

Analysis of Geographic, Temporal, and Socioeconomic Shifts in Pedestrian & Bicyclist Traffic Injuries

Final Report

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16. Abstract This research project explores changes in pedestrian and bicyclist injuries that occurred in Wisconsin between 2008 and the early 2020s. Our analyses of pedestrian and bicyclist fatal and severe injury (FSI) crashes found that both pedestrian FSI and bicyclist FSI crashes were consistently related to high-volume arterial roadways and overrepresented among the Black population; pedestrian FSI crashes were consistently overrepresented in communities with higher shares of Hispanic and lower-income residents. Shifts over time included absolute pedestrian FSI crash increases and proportional bicyclist FSI crash increases in the SE Region, pedestrian FSI crash increases in larger cities, and pedestrian FSI crash increases at night. Practitioner interviews suggested that dispersed development, driver behavior, and pedestrian activity at night may have contributed to increases in pedestrian and bicyclist injuries during the 2010s. Interviews also highlighted strategies to improve pedestrian and bicyclist safety, including to establish plans and policies, redesign roadways, and increase resources for pedestrian and bicyclist safety projects. These results can help practitioners develop a better understanding of where and when to focus engineering, education, enforcement, and other safety efforts.			
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EXECUTIVE SUMMARY

Between 2008-2012 and 2018-2022, the average annual number of pedestrians killed in US traffic crashes increased by 55% (from 4,420 to 6,841 per year) and in Wisconsin traffic crashes increased by 24% (from 53.6 to 66.2 per year). The average annual number of bicyclists killed in US traffic crashes increased by 41% (from 677 to 952 per year) and in Wisconsin traffic crashes increased by 10% (from 9.6 to 10.6 per year) between these two periods.

This research project is a part of broad efforts by the Wisconsin Department of Transportation (WisDOT) to improve pedestrian and bicyclist safety. It also complements a national study conducted by the United States Department of Transportation (USDOT)-funded Center for Pedestrian and Bicyclist Safety University Transportation Center (CPBS UTC) to better understand and combat the overall national increase in pedestrian and bicyclist fatalities over the last 15 years.

This WisDOT research project explores changes in pedestrian and bicyclist injuries that occurred in Wisconsin between 2008 and the early 2020s, with the end date depending on the latest data available at the time of the analysis. Our primary purpose is to identify where and when increases (or decreases) in pedestrian and bicyclist injuries occurred so that practitioners can develop a better understanding about where and when to focus engineering, education, enforcement, and other safety efforts.

Research Approach

Our research team collected several types of data to explore shifts in pedestrian and bicyclist fatal and severe injury (FSI) crashes between 2008 and the early 2020s. Our quantitative data included police-reported crash records; land use, job, and socioeconomic data from census tracts; and transit stop locations. We analyzed crashes from Wisconsin, but we also made comparisons with eight other states: California, Colorado, Massachusetts, Minnesota, New York, Oregon, Pennsylvania, and Washington.

We collected qualitative data by interviewing local and regional agency planners and engineers who work on pedestrian and bicyclist safety issues. The interviews were conducted in March and April 2025 and covered transportation system policy, budget, project implementation, and other contextual changes (e.g., population growth/decline, development activity, pedestrian and bicyclist activity, automobile traffic patterns) that practitioners thought were associated with pedestrian and bicyclist safety changes in their communities during the 2010s.

Findings

Our analyses revealed several key findings about shifts in pedestrian and bicyclist injuries in Wisconsin between 2008 and the early 2020s. This section summarizes these main findings and discusses their implications for safety practice. We also created an online StoryMap to communicate the results from this study. It illustrates how pedestrian and bicyclist crash hot spots have shifted and highlights other crash trends in Wisconsin since 2008. This resource is available at:

<https://storymaps.arcgis.com/stories/e98430b148e44665ac1004158b37f1cd>

Crashes that produced pedestrian and bicyclist fatalities increased over time, while low severity crashes decreased. Across nine states, including Wisconsin, fatal pedestrian crashes and fatal bicyclist crashes generally increased more than crashes that produced low severity pedestrian and bicyclist injuries between 2008 and 2022. The COVID pandemic in 2020 appeared to reduce lower severity (B and C) pedestrian and bicyclist crashes, which may track more closely with overall pedestrian and bicyclist activity levels, or exposure.

Younger age groups had the highest pedestrian FSI crash rates and bicyclist FSI crash rates, but the rates for these younger groups decreased while rates for several older age groups increased.

Pedestrians aged 15-19 and 20-24 had the highest FSI rates in Wisconsin, but population-based injury rates for these two age groups decreased notably between 2008-2012 and 2017-2021. In contrast, FSI rates for pedestrians in the age categories between 25 and 74 increased. The highest bicyclist FSI rates were for bicyclists aged 15 to 34, but injury rates in the youngest age groups (1-14, 15-19, and 20-24) decreased notably between the two time periods. In contrast, FSI rates for bicyclists in the older age categories (65-74 and 75+) increased. Note that pedestrian injury rate changes for certain age groups may be due to changes in risk (e.g., characteristic of the system, such as vehicles or roadways, or user behavior within the system) or changes in pedestrian exposure.

People who are Black were overrepresented as pedestrians, bicyclists, and drivers in FSI pedestrian crashes and FSI bicyclist crashes. People who are Black had the highest population-based rates of FSI pedestrian and FSI bicyclist crashes during the 2021-2023 period (more than twice as high as any other racial or ethnic group). They also had the highest rates of being drivers in crashes resulting in FSI pedestrian and FSI bicyclist crashes. Race and ethnicity information has only been included in the Wisconsin crash database since 2017, so we did not analyze these trends over time.

FSI pedestrian crash locations shifted toward areas with moderate suburban residential densities and FSI bicyclist crash locations shifted toward areas with dense urban residential densities. Overall, FSI pedestrian crashes were most common in dense urban area types (>2,000 people per square mile) in both time periods. However, pedestrian crashes with serious injuries shifted slightly away from dense urban areas and rural areas toward suburban areas (100-2,000 people per square mile) between 2008-2012 and 2018-2022. FSI bicyclist crashes shifted toward dense urban areas from other area types between these time periods.

The WisDOT SE Region had the most FSI pedestrian and FSI bicyclist crashes and also experienced an increasing share of statewide crashes. Approximately half of all Wisconsin FSI pedestrian crashes occurred in the SE Region in 2008-2012 and 2018-2022. The SE Region was the only region to experience an absolute increase in FSI pedestrian crashes between these periods. The largest number of FSI bicyclist crashes was also in the SE Region. While absolute numbers of FSI bicyclist crashes decreased in all regions, the proportion of FSI bicyclist crashes occurring in the SE Region increased from 35% to 39%.

Larger cities tended to experience more increases in FSI pedestrian crashes than other parts of the state. Statewide, there was a 2.5% decrease in FSI pedestrian crashes between 2008-2012 and 2017-2021. However, Wisconsin's 20 largest cities actually experienced a 7.4% increase in FSI pedestrian crashes during this time. While some of the 20 largest cities saw decreases, Milwaukee, West Allis, Sheboygan, and Greenfield experienced increases of 24% or more.

FSI bicyclist crashes decreased statewide, but this may be related to decreases in bicycling activity. Statewide, as well as the largest 20 cities in Wisconsin, experienced a nearly 30% decrease in the number of FSI bicyclist crashes between 2008-2012 and 2017-2021. However, the decrease per 1000 bike commuters was less pronounced, indicating that some of the decreases in raw FSI bicyclist crashes could be due to the 23% decline in bicycling to work between the earlier and later study periods. Note that bicycle commuting data does not account for recreational bicycling, so other exposure variables are needed to fully represent how overall levels of bicyclist activity are changing over time.

More FSI pedestrian crashes occurred in census tracts with certain socioeconomic and transportation system characteristics. There were more FSI pedestrian crashes in Wisconsin census tracts with higher shares of Hispanic residents, with lower median incomes, close to transit stops, and containing arterial

roadways with more than 20,000 AADT in both 2008-2012 and 2017-2021. FSI pedestrian crashes were also associated with shares of public transit commuters, Black residents, and retail jobs in 2017-2021.

More FSI bicyclist crashes occurred in census tracts with certain transportation system and socioeconomic characteristics. Compared to other tracts, there were more FSI bicyclist crashes in Wisconsin census tracts with arterial roadways with more than 20,000 AADT in both 2008-2012 and 2017-2021. Tracts with higher shares of unemployed workers had significantly more FSI bicyclist crashes in 2008-2012 but not in 2017-2021.

Many FSI pedestrian crashes occurred near bus stops. Approximately half of Wisconsin FSI pedestrian crashes were within 0.1 miles of a bus stop, and about 30% were within 50 meters of a bus stop. These patterns did not shift notably between 2008-2012 and 2018-2022. They highlight the association between crashes and corridors served by transit, which often have high levels of pedestrian activity.

FSI pedestrian crashes peaked in September through November, and FSI bicyclist crashes peaked in July through September, with the seasonal pattern of bicyclist injuries becoming more pronounced over time. Wisconsin FSI pedestrian crashes tended to peak in the season with decreasing sunlight, the beginning of the school year, the transition from daylight saving time back to standard time, and moderate temperatures that support pedestrian activity. Most FSI bicyclist crashes occurred during the warm summer months, and these summer crashes became more common between 2008-2012 and 2018-2022.

FSI pedestrian crashes were most common in the late afternoon on weekdays and at night on Friday and Saturdays, and they shifted toward early evenings, early night, and very early mornings over time. Comparing 2008-2012 with 2018-2022 showed increasing proportions of Wisconsin FSI pedestrian crashes during early evenings (6-8 pm), early night (9-11 pm), and very early mornings (3-5 am). These shifts occurred broadly across different parts of the state.

FSI bicyclist crashes were more likely to occur on weekdays than on Saturday and Sunday. Higher proportions of Wisconsin FSI bicyclist crashes tended to happen during the afternoon and early evening on weekdays, and this temporal pattern was stable between 2008-2012 and 2018-2022.

Practitioners suggested that dispersed development, driver behavior, and pedestrian activity at night may have contributed to increases in pedestrian and bicyclist injuries during the 2010s. These were the most common themes participants mentioned during interviews.

Practitioners highlighted multiple strategies they used to improve pedestrian and bicyclist safety in their communities. These positive strategies included many interrelated actions: establish plans and policies, redesign roadways, receive support from local advocates, receive support from elected officials, increase resources for pedestrian and bicyclist safety projects, collaborate with WisDOT, and institutionalize pedestrian and bicyclist safety practices.

Implications for Practice

Pedestrian and bicyclist fatalities increased in Wisconsin between 2008 and the early 2020s, but this increase was less than many other states. Still, there were several concerning safety trends, including absolute pedestrian FSI crash increases and proportional bicyclist FSI crash increases in the SE Region. Pedestrian FSI and bicyclist FSI crashes were consistently related to high-volume arterial roadways and were overrepresented among the Black population. Pedestrian FSI crashes increased in larger cities and at night and were consistently overrepresented in areas with higher shares of Hispanic and lower-income residents. These trends can inform prioritization of safety resources and help direct engineering, education, and enforcement strategies toward certain areas, times, and population groups.

Specifically, the results from this research project suggest several project delivery strategies and internal organization strategies that WisDOT could consider to create a safer statewide transportation system for pedestrians and bicyclists. In practice, these strategies will be balanced with other considerations such as cost impacts or the need for legislative approval, but they indicate important directions for WisDOT to explore. More details about these strategies are provided in the body of the report.

WisDOT Project Delivery Strategies

- Prioritize investments in multimodal roadway reconstruction projects in developed areas.
- Dedicate additional resources for pedestrian and bicyclist safety within WisDOT projects on urban state highways, rural main streets, and other arterial roadways with high existing and potential pedestrian and bicyclist activity levels.
- Dedicate additional resources for pedestrian safety improvements within the WisDOT Southeast Region and other large cities.
- Dedicate additional resources to improve pedestrian safety at night on WisDOT and local roadways.

WisDOT Internal Organization Strategies

- Continue to support policies to incorporate pedestrian and bicycle accommodations as a part of multimodal roadway projects.
- Ensure that all divisions within WisDOT consider pedestrian and bicyclist safety as a core part of their day-to-day work.
- Adopt a context-based approach for setting speed limits.
- Prioritize and communicate multimodal safety performance and person-based capacity metrics over automobile level of service.
- Continue to make pedestrian and bicyclist safety analysis more proactive.
- Expand the types of injury data used to analyze and make decisions about pedestrian and bicyclist safety.

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1. INTRODUCTION

This research project is a part of broad efforts by the Wisconsin Department of Transportation (WisDOT) to improve pedestrian and bicyclist safety. The average number of pedestrians killed in Wisconsin traffic crashes increased by 24% (from 53.6 to 66.2 per year) between 2008-2012 and 2018-2022. The average number of bicyclists killed in Wisconsin traffic crashes increased by 10% (from 9.6 to 10.6 per year) between these two periods.¹ Fortunately, non-fatal injuries to pedestrians and bicyclists decreased between these two periods, but the increase in fatalities to both pedestrians and bicyclists is concerning. “Improve Pedestrian Safety” and “Improve Bicyclist Safety” are identified as two of the WisDOT 2023-2027 Strategic Highway Safety Plan topics.²

Understanding where, when, and to whom crashes are occurring is essential to preventing future pedestrian and bicyclist injuries. This project complements a national study conducted by the United States Department of Transportation (USDOT)-funded Center for Pedestrian and Bicyclist Safety University Transportation Center (CPBS UTC) to better understand and combat the overall national increase in pedestrian and bicyclist fatalities over the last 15 years.

During Year 1 of the CPBS UTC project, the University of Wisconsin-Milwaukee (UWM) team conducted a preliminary analysis of fatal and severe injury (FSI) pedestrian crashes in eight states and found that increases in these crashes during the 2010s were associated with the proportion of retail jobs, unemployed workers, as well as low-income and Black and Hispanic populations.³ The Year 1 analysis provided new insights, but it did not examine bicyclist crashes, geographic shifts in relation to central business districts or regional retail centers, shifts in the time of day when crashes occurred, differences between urban and rural contexts, or roadway characteristics associated with increases in FSI crashes.

This WisDOT research project aims to fill these gaps in knowledge, specifically in Wisconsin. It includes quantitative analyses of pedestrian and bicyclist crash data as well as practitioner interviews about transportation infrastructure, policy, or land development changes that may have contributed to shifts in patterns of pedestrian and bicyclist fatal and severe injury (FSI) crashes. It explores changes that occurred between 2008 and the early 2020s (end date depending on the latest data available at the start of analysis).

¹ Wisconsin Traffic Operations and Safety Laboratory. (2024). The WisTransPortal System, <https://transportal.cee.wisc.edu/services/crash-data/>.

² Wisconsin Department of Transportation. (2023). Strategic Highway Safety Plan, 2023-2027. <https://drive.google.com/file/d/1uxzbCcmtzTJKKvtBqyyNbHdIs8P78NzT/view>.

³ Schneider, R.J., X. Gu, K. Nelson, and N.N. Ferenchak. (2024). Geographic and Temporal Shifts in Fatal and Severe Pedestrian Crashes, Center for Pedestrian and Bicyclist Safety University Transportation Center (CPBS UTC), University of Wisconsin-Milwaukee.

We investigated the following questions about shifts in pedestrian and bicyclist safety in Wisconsin:

- 1) How much did fatal, severe, and non-severe pedestrian and bicyclist injuries change?
- 2) What geographic shifts occurred in fatal and severe pedestrian and bicyclist injuries?
- 3) What temporal shifts occurred in fatal and severe pedestrian and bicyclist injuries?
- 4) Why did these geographic and temporal shifts in fatal and severe pedestrian and bicyclist injuries occur? What demographic or socioeconomic characteristics were associated with these shifts?
- 5) How do shifts in Wisconsin pedestrian and bicyclist injuries compare with shifts in other states?

By identifying where and when the increases (or decreases) in pedestrian and bicyclist injuries have occurred, practitioners can develop a better understanding about where and when to focus engineering, education, enforcement, and other safety efforts.

2. DATA COLLECTION

Our research team collected several types of data to explore shifts in pedestrian and bicyclist FSI crashes between 2008 and the early 2020s. Our baseline was generally the five-year period, 2008-2012, and our later period was often 2017-2021 or 2018-2022, depending on the latest data available when we started a particular analysis. A few of our analyses examine data through 2023 or 2024. We chose 2008 through the 2020s as our study period because it corresponds with steady increase in pedestrian and bicyclist fatalities throughout the 2010s and into the early 2020s at the national level, even though Wisconsin did not experience as steep of an increase as other parts of the country.

Our quantitative data included police-reported crash records; land use, job, and socioeconomic data for census tracts; and transit stop locations. Our qualitative data were interview responses from local and regional agency planners and engineers who work on pedestrian and bicyclist safety issues.

2.1. Police-Reported Crash Data

To explore shifts in pedestrian and bicyclist FSI crashes, we gathered approximately 15 years of state-level pedestrian and bicyclist crash data (from 2008 to 2021 or 2022) from eight states: California, Colorado, Massachusetts, New York, Oregon, Pennsylvania, Washington, and Wisconsin. We also gathered crashes from Minnesota for several analyses, as noted in the sections below. The crash files from each state contained somewhat different variables and were formatted somewhat differently, so we cleaned the data to create consistent data fields across all states. Then, we organized pedestrian and bicyclist crashes into separate databases. Across the states, we focused on crash location, hour of the week, month of the year, and pedestrian or bicyclist injury severity level (KABCO scale).

We gathered Wisconsin crashes from the WisTransPortal database. Our Wisconsin-specific analysis was able to use more variables than our national analysis because of the consistency of data within a single state. We focused on characteristics such as: crash hour of week and month of year; longitude and latitude; WisDOT region; city; roadway type; injury severity (KABCO scale); pedestrian, bicyclist, and driver age; pedestrian with disabilities (DNMFTR flag for PHY IMP, WCHAIR, BLIND, or CANE in WisTransPortal); and pedestrian, bicyclist, and driver race (available after 2018 in WisTransPortal). Note that Wisconsin’s police crash reporting form was updated from the MV4000 to the DT4000 to comply with the latest national standards in 2017. We did not detect notable changes in our longitudinal analysis of pedestrian and bicyclist injuries based on this change, but it could have resulted in slight differences.

Several of our Wisconsin-specific analyses include geographic context data from other sources, such as population density and bus stop locations. We associated these geographic context variables with crashes using the latitude and longitude coordinates provided in the WisTransPortal database, so our analyses of these specific characteristics only consider geocoded crashes (i.e., crashes with latitude and longitude coordinates). Geocoding rates for pedestrian and bicyclist crashes improved over the years that we studied, so it is important to recognize that later years include more geocoded crashes (Table 1).

Table 1. Geocoding Rates for Pedestrian and Bicyclist Crashes in the WisTransPortal Database

Year	Total Pedestrian Crashes			% Ped Crash Geocoded			Total Bicyclist Crashes			% Bike Crash Geocoded		
	All	K	A	All	K	A	All	K	A	All	K	A
2008	1665	59	304	72.7%	84.7%	78.0%	1134	9	120	86.5%	77.8%	94.2%
2009	1551	40	275	73.0%	85.0%	76.7%	1115	7	118	85.7%	100.0%	93.2%
2010	1611	56	268	73.2%	94.6%	82.1%	1173	9	109	86.8%	88.9%	89.9%
2011	1579	62	258	71.8%	82.3%	71.7%	1121	12	106	87.7%	91.7%	88.7%
2012	1634	48	262	72.6%	87.5%	79.4%	1224	11	115	88.2%	100.0%	87.8%
2013	1644	42	254	72.3%	76.2%	78.0%	1021	10	87	88.5%	100.0%	95.4%
2014	1525	44	225	73.5%	79.5%	84.0%	991	4	95	89.2%	100.0%	89.5%
2015	1638	55	255	75.0%	83.6%	79.2%	1047	14	74	90.4%	100.0%	94.6%
2016	1628	53	247	73.8%	94.3%	75.3%	988	11	108	90.0%	81.8%	94.4%
2017	1533	56	277	91.6%	94.6%	89.2%	906	7	78	92.4%	71.4%	97.4%
2018	1505	55	266	93.2%	100.0%	94.4%	852	5	74	93.9%	100.0%	90.5%
2019	1460	52	275	98.1%	100.0%	98.9%	759	14	81	98.2%	100.0%	98.8%
2020	1137	50	246	98.2%	100.0%	98.4%	619	12	75	98.9%	100.0%	100.0%
2021	1273	49	266	97.5%	100.0%	97.0%	691	9	87	99.1%	100.0%	98.9%
2022	1324	73	256	98.5%	100.0%	99.2%	668	14	70	99.9%	100.0%	100.0%
2023	1299	62	248	99.0%	100.0%	99.6%	791	7	92	99.5%	100.0%	100.0%
2024	1385	58	249	98.9%	100.0%	99.2%	894	8	106	99.6%	100.0%	99.1%

Future research beyond this project scope should also look at injuries from other sources, such as EMS or hospital data, to provide a more complete picture of injuries to all vulnerable roadway users, including electric scooter users (Schneider, Willman, and Hargarten 2023).

2.2. Contextual Data

To understand the context surrounding the pedestrian and bicyclist crashes during our baseline and later study periods, we gathered data for all census tracts in the nine states. These included neighborhood socioeconomic characteristics from the American Community Survey, jobs by major employment category from Longitudinal Employment Household Dynamics (LEHD), population and job density and land use mix data from the Environmental Protection Agency (EPA) Smart Location Database, roadway system data (e.g., number of lanes, traffic volumes) from the Highway Performance Management System (HPMS). For most data sources, we gathered data from a time period at the beginning of the 2010s (typically 2008-2012) and a time period at the end of the 2010s (either 2017-2021 or 2018-2022). In some cases, the data were from the 2010 Census and 2020 Census. The HPMS traffic data were from 2016, a single year close to the middle of the entire analysis period. We also used 2018 statewide bus stop location data that were gathered from local transit agencies in a previous study.

2.3. Statistical Analyses

We explored pedestrian and bicyclist crash trends in Wisconsin using several common statistical techniques. These included descriptive statistics and negative binomial models of the number of pedestrian or bicyclist crashes in each census tract during different time periods. Each of these approaches is described along with corresponding results in the next section of the report.

We also used several advanced analytical approaches to explore pedestrian and bicyclist crash trends. Due to space constraints, these are included as appendices rather than in the main body of the report. Specifically, we applied space-time cube analysis and emerging hot spot analysis to identify temporal changes in spatial patterns of pedestrian and bicyclist crashes (Appendix A). We also developed a sequential modeling framework that integrates spatial models with machine learning (ML) techniques to analyze pedestrian crash frequency at the census tract level (Appendix B). This framework has two steps. First, two Conditional Autoregressive (CAR) models; the Poisson-Gamma CAR (P-G CAR) and Poisson-Lognormal CAR (P-L CAR) are applied to estimate the neighborhood-level determinants of pedestrian crashes. Second, residuals from the CAR models were analyzed using ML algorithms with SHapley Additive exPlanations (SHAP) to improve model predictions.

2.4. Interview Data

We also gathered qualitative data to explore pedestrian and bicyclist crash shifts in Wisconsin over time. Specifically, we conducted interviews with professionals in several local and regional agencies to explore why they thought pedestrian and bicyclist safety outcomes might have changed in their communities

during the 2010s. The interviews were conducted in March and April 2025 and included transportation planners or engineers. To be eligible to participate in the interview, the professional needed to have been working on issues related to pedestrian or bicyclist safety in their community for at least five years between 2010 and 2020.

We asked interview participants to discuss transportation system policy, budget, project implementation, and other contextual changes (e.g., population growth/decline, development activity, pedestrian and bicyclist activity, automobile traffic patterns) that they thought could be associated with pedestrian and bicyclist safety changes (Appendix C).

Our interview protocol was approved by the UWM Institutional Research Board. While our protocol requires us to keep our interview participants anonymous, we interviewed practitioners at six different agencies across Wisconsin. Insights from these interviews provided important lessons for communities seeking to make progress towards zero pedestrian and bicyclist fatalities.

3. ANALYSIS AND RESULTS

This section shows how we analyzed our quantitative and qualitative data to explore shifts in pedestrian and bicyclist FSI crashes between 2008 and the early 2020s. We present our findings in each subsection after describing our analytical approach. For each chart in the body of the report we also include a corresponding data table in Appendix D.

3.1. Injury Severity Shifts

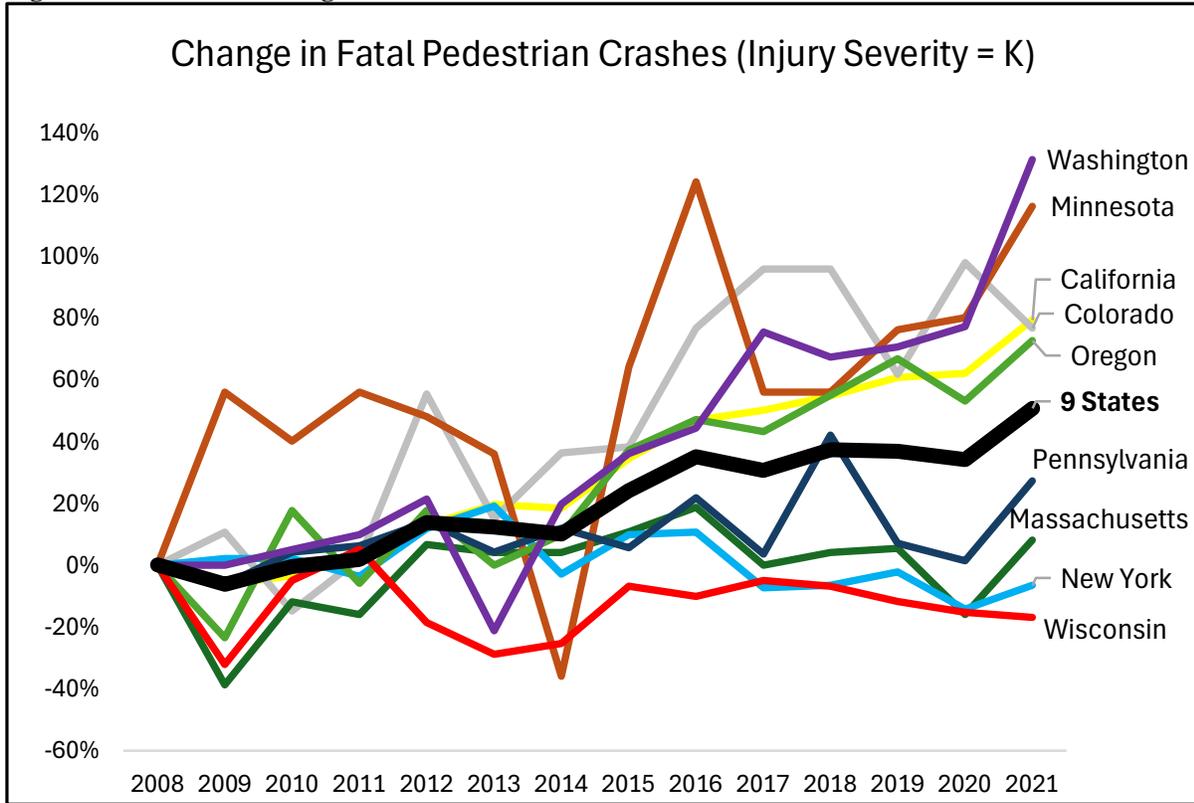
3.1.1. Injury Severity Shifts in Nine States

We analyzed crash-level data to explore changes in pedestrian and bicyclist injury severity levels from 2008 to 2021 across nine states.⁴ Overall, crashes that produced pedestrian fatalities (“K” on the KABCO injury scale) in these nine states increased by an average of 51% during this period. However, there was a wide range of changes between states, with Washington (+131%) and Minnesota (+116%) experiencing

⁴ Crash-level data have a single record for each crash, regardless of the number of people involved in it. Each record indicates whether or not a pedestrian or bicyclist was one of the parties involved in the crash, but it does not say how many total pedestrians or bicyclists were involved. For consistency across the full nine-state database, each record only indicates the most severe injury sustained in the crash. This is almost always the pedestrian or bicyclist, but there are exceptions. For example, if there is a crash in which two pedestrians were struck by a vehicle and one sustained an “A”-level injury and the other sustained a “B”-level injury, the crash record would only show the most severe injury (“A” level).

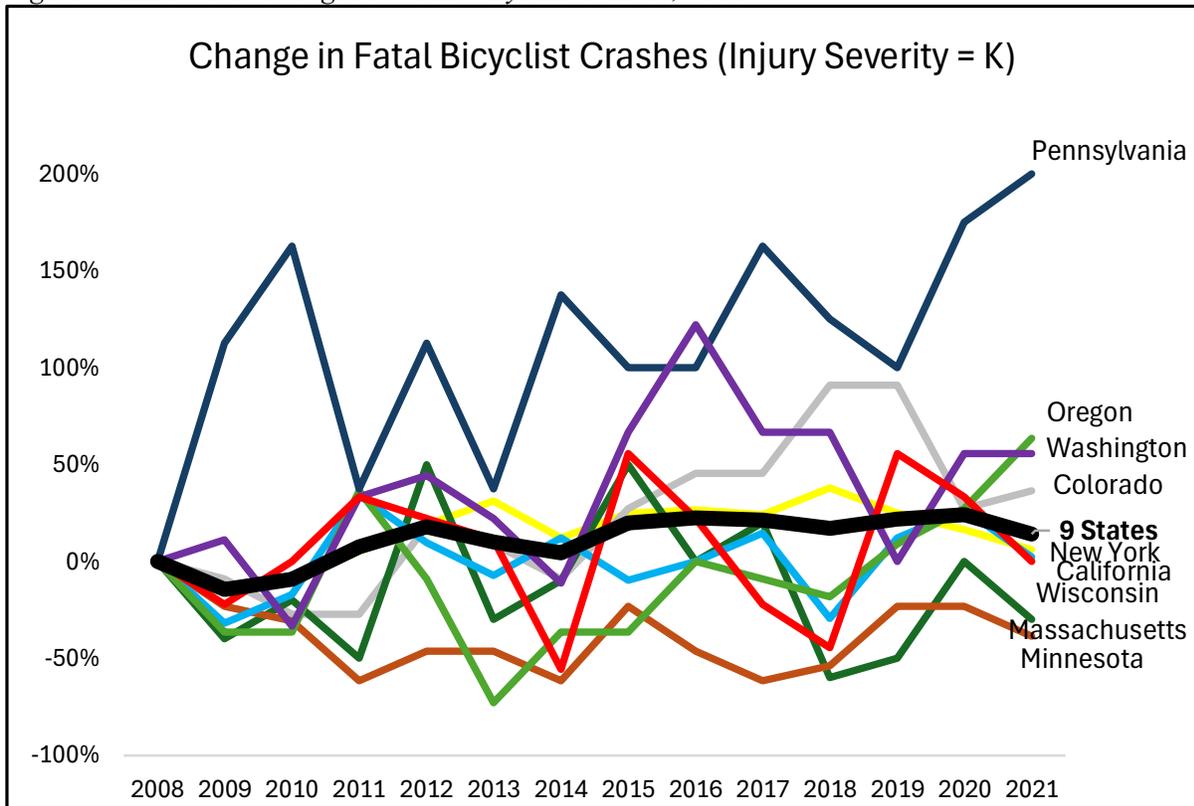
the greatest increases and New York (-7%) and Wisconsin (-17%) experiencing decreases (Figure 1). However, these trends exhibit fairly high levels of year-to-year variation, especially in less-populous states. For example, fatal pedestrian crashes in Wisconsin increased from 49 in 2021 (last year on graph) to 73 in 2022.

Figure 1. State-Level Changes in Fatal Pedestrian Crashes, 2008-2021



Overall, crashes that produced bicyclist fatalities in these nine states increased by an average of 14% during this period. The greatest increase was in Pennsylvania (+200%) and largest decrease was in Minnesota (-38%) (Figure 2). Wisconsin’s annual fatal bicyclist crash numbers fluctuated throughout the study period but were the same in 2008 and 2021. Bicyclist fatality trends by state show even higher levels of year-to-year variation than pedestrian fatality trends, likely due to lower levels of bicyclist activity and fewer total fatal bicyclist crashes.

Figure 2. State-Level Changes in Fatal Bicyclist Crashes, 2008-2021



We also analyzed trends in pedestrian and bicyclist crashes across the injury severity spectrum. Specifically, we combined data from all nine states to compare year-to-year changes in crashes producing fatal injuries (“K”), severe injuries (“A”), moderate injuries (“B”), and minor or possible injuries (“C”). Between 2008 and 2021, crashes that produced more serious pedestrian and bicyclist injuries generally increased more than crashes that produced less serious pedestrian and bicyclist injuries (Figure 3 and Figure 4). In addition, the COVID pandemic in 2020 appeared to produce a greater reduction in less severe pedestrian and bicyclist crashes. Trends in lower injury severity crashes may track more closely with overall pedestrian and bicyclist activity levels, or exposure.

Figure 3. Change in Pedestrian Crashes in Nine States by Injury Severity Level, 2008-2021

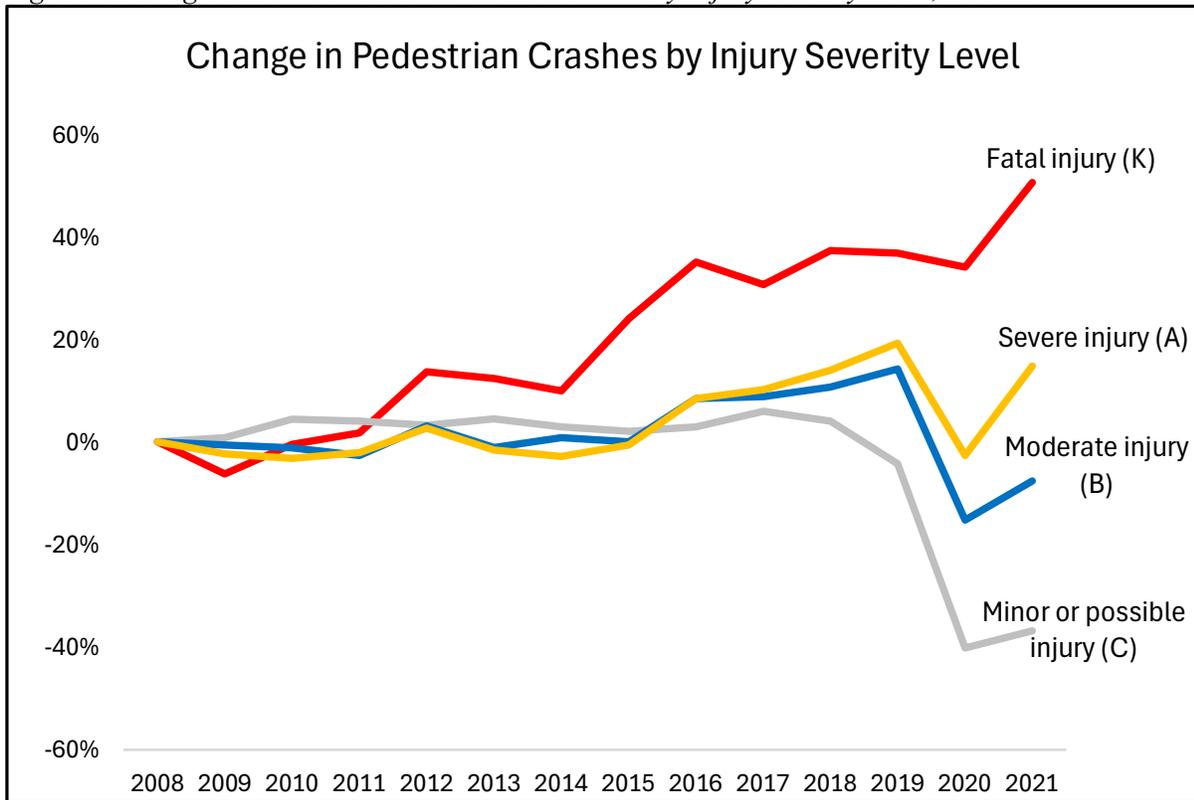
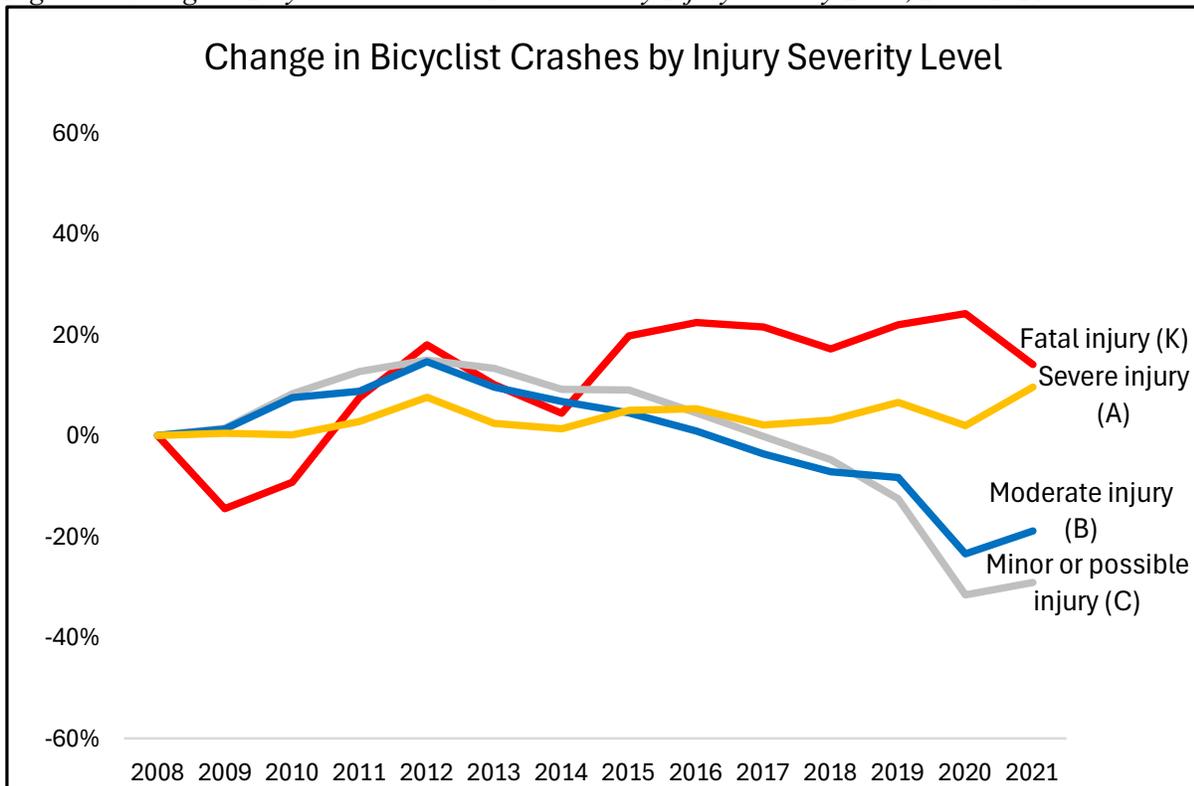


Figure 4. Change in Bicyclist Crashes in Nine States by Injury Severity Level, 2008-2021

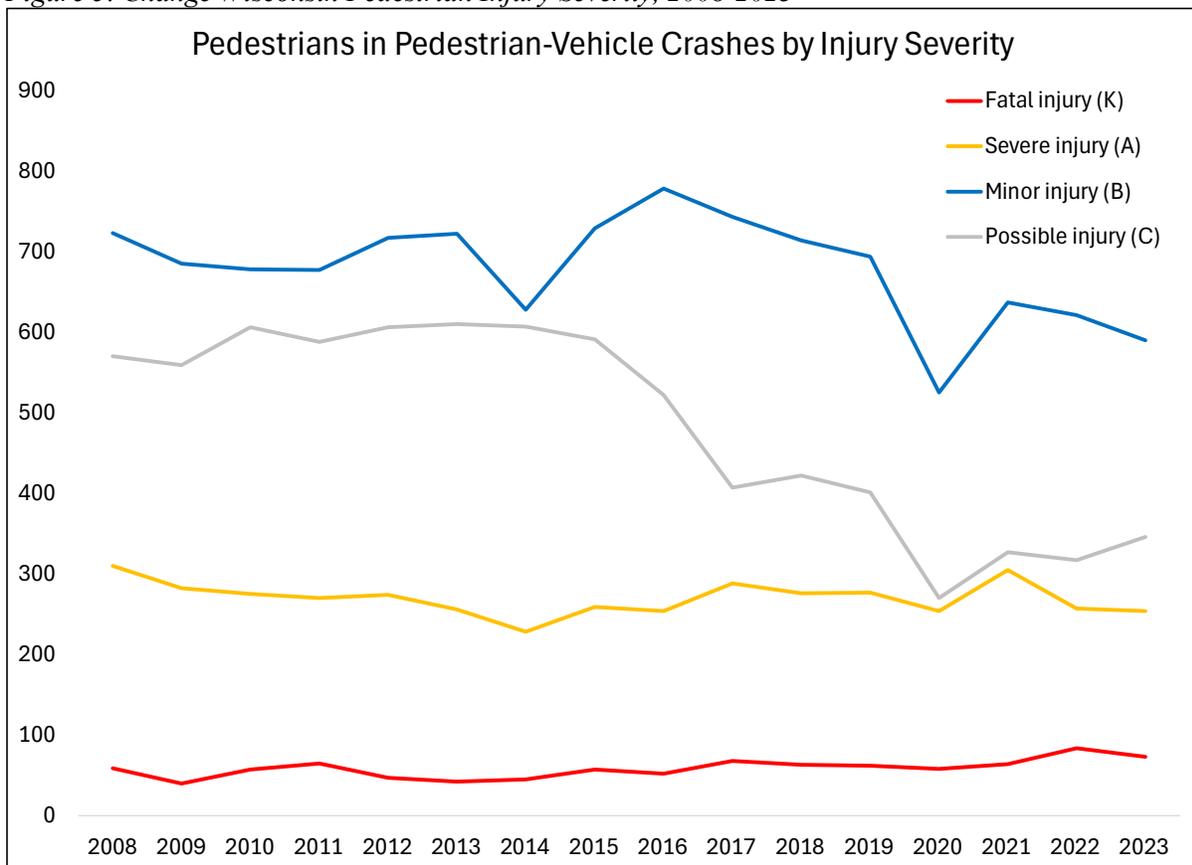


3.1.2. Injury Severity Shifts in Wisconsin

We used person-level data in Wisconsin to explore the number of pedestrian and bicyclist injuries sustained each year between 2008 and 2023 at each injury level in all crashes.⁵

Similar to the trend in all nine states, Wisconsin had an increase in pedestrian fatalities but decreases in less severe pedestrian injuries (Figure 5). We also compared pedestrian injury rates per 100,000 population between 2008-2012 and 2017-2021 to account for the influence of state-level population change on the number of pedestrian injuries over time (Appendix D, Table D.5). Pedestrian fatality rates increased from 0.94 per 100,000 people during 2008-2012 to 1.07 during 2017-2021. However, pedestrian injury rates at all other injury severity levels decreased between these two time periods. This pattern could reflect decreased risk from improved pedestrian facilities and education or decreased pedestrian exposure.

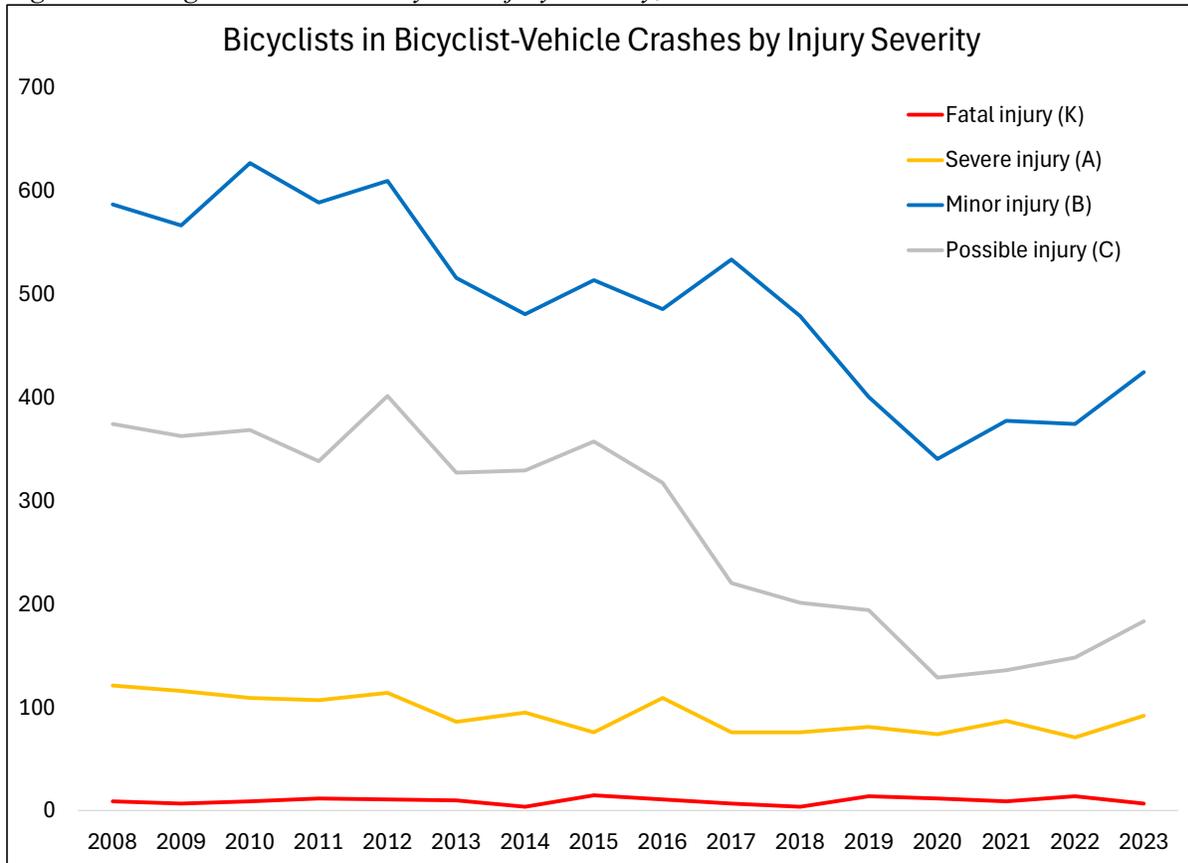
Figure 5. Change Wisconsin Pedestrian Injury Severity, 2008-2023



⁵ Person-level data include a record for each individual person involved in a crash. For example, a crash in which a vehicle strikes two pedestrians will have two (potentially different) pedestrian injury severity levels recorded.

Our person-level analysis of Wisconsin bicyclist crashes showed that there were a small number of bicyclist fatalities, so there was no clear trend over time. Minor (“B”) and possible (“C”) injuries generally decreased between 2008 and 2020, possibly reflecting decreasing levels of bicyclist activity. However, these less-severe injury categories increased again after 2020. Comparing bicyclist injury rates per 100,000 population between 2008-2012 and 2017-2021 showed decreases at all injury severity levels (even a slight decrease in bicyclist fatality rates) (Appendix D, Table D.6).

Figure 6. Change in Wisconsin Bicyclist Injury Severity, 2008-2023



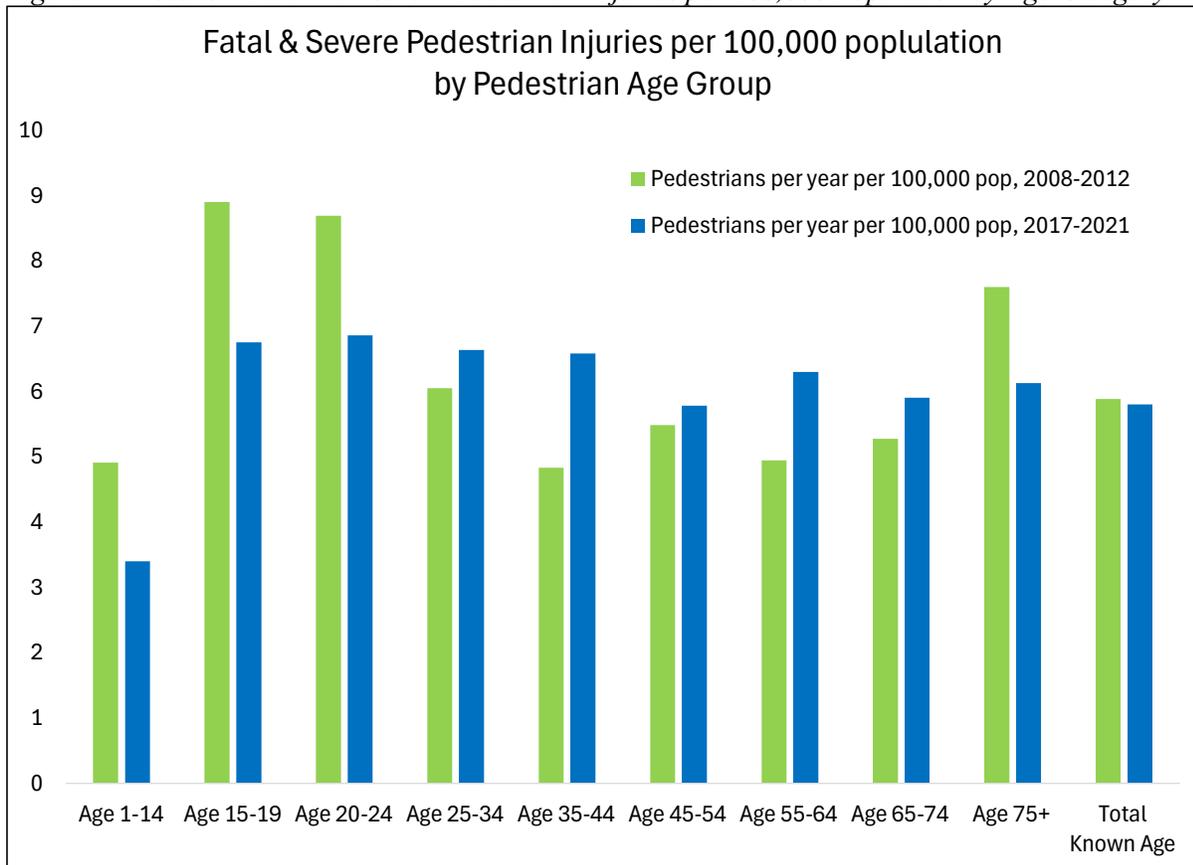
3.2. Demographic Shifts in Wisconsin Fatal and Serious Pedestrian and Bicyclist Injuries

We also examined shifts in the demographic characteristics (e.g., age, gender, race) of pedestrians and bicyclists injured in Wisconsin crashes. This person-level analysis focused specifically on fatal (“K”) and severe (“A”) injuries. We also examined the demographic characteristics of drivers involved in these serious pedestrian and bicyclist crashes.

3.2.1. Age

Overall, the total number of pedestrian fatal and severe injuries per 100,000 population in Wisconsin decreased slightly from 5.89 in 2008-2012 to 5.81 in 2017-2021 (Figure 7). While pedestrians aged 15-19 and 20-24 had the highest fatal and severe injury rates, the injury rates for these two age groups decreased notably between the two time periods. In contrast, injury rates for pedestrians in the age categories between 25 and 74 increased between 2008-2012 and 2017-2021. Note that pedestrian injury rate changes for certain age groups may be due to changes in risk (e.g., characteristic of the system, such as vehicles or roadways, or user behavior within the system) or changes in pedestrian exposure.

Figure 7. Wisconsin Fatal and Severe Pedestrian Injuries per 100,000 Population by Age Category



The highest rates of drivers being involved in a crash that produced a fatal or severe pedestrian injury were in the younger age categories of drivers (between ages 15 and 34) (Figure 8). Interestingly, drivers aged 15-19 and 20-24 experienced the largest decreases in fatal or severe pedestrian injury rates between 2008-2012 and 2017-2021. The only driver age category to have an increase in fatal or severe pedestrian injury rates between these two periods was drivers aged 35-44.

Overall, the total number of bicyclist fatal and severe injuries per 100,000 population in Wisconsin decreased from 2.16 in 2008-2012 to 1.49 in 2017-2021 (Figure 9). The highest injury rates were to bicyclists aged 15 to 34, but injury rates in the youngest age groups (1-14, 15-19, and 20-24) decreased notably between the two time periods. In contrast, injury rates for bicyclists in the older age categories (65-74 and 75+) increased between 2008-2012 and 2017-2021.

Figure 8. Drivers involved in Wisconsin Fatal or Severe Pedestrian Injury Crashes per 100,000 population by Driver Age Category

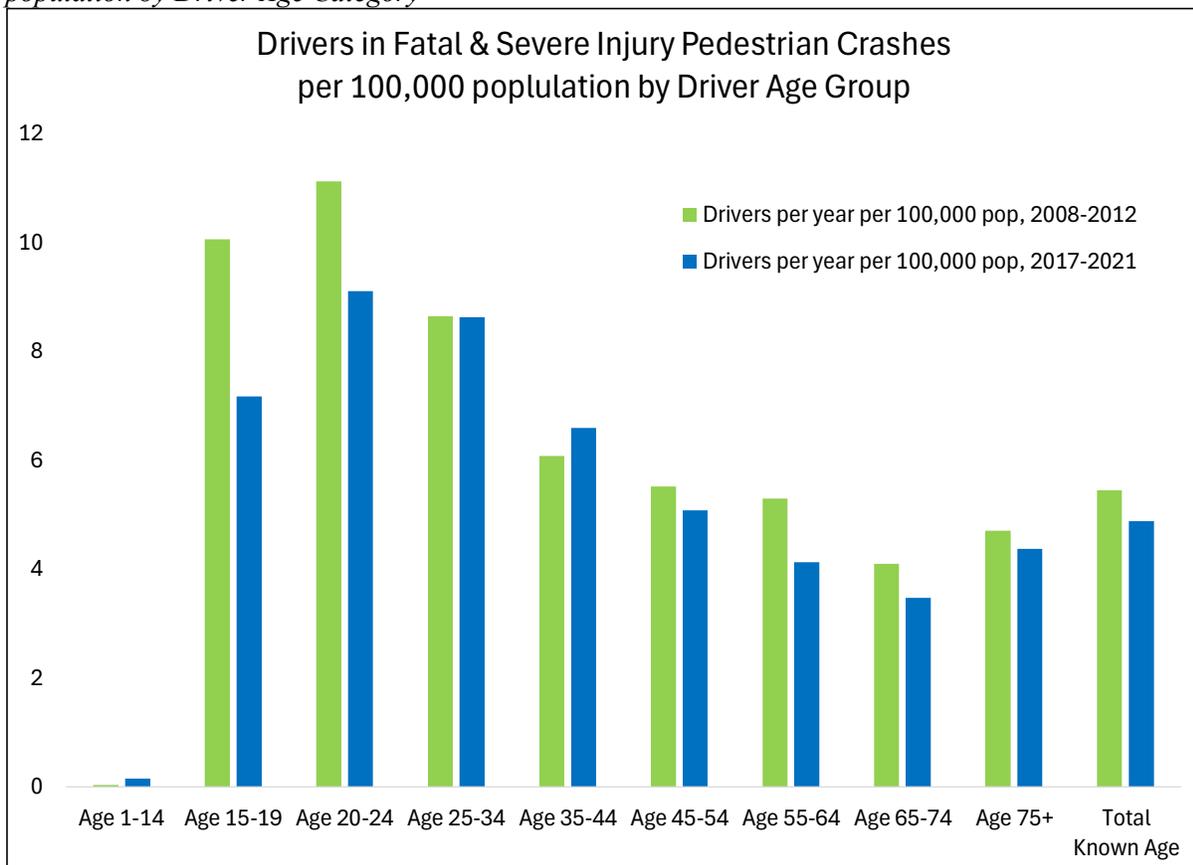
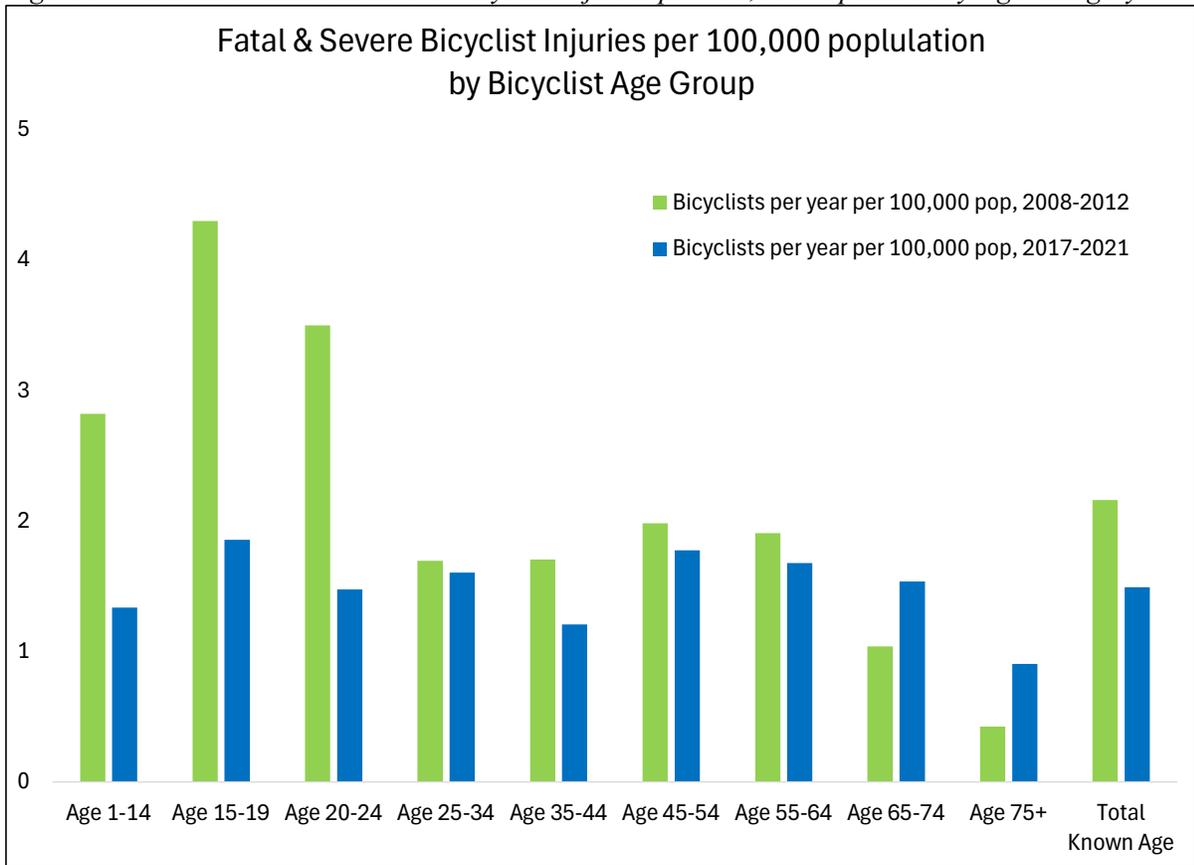
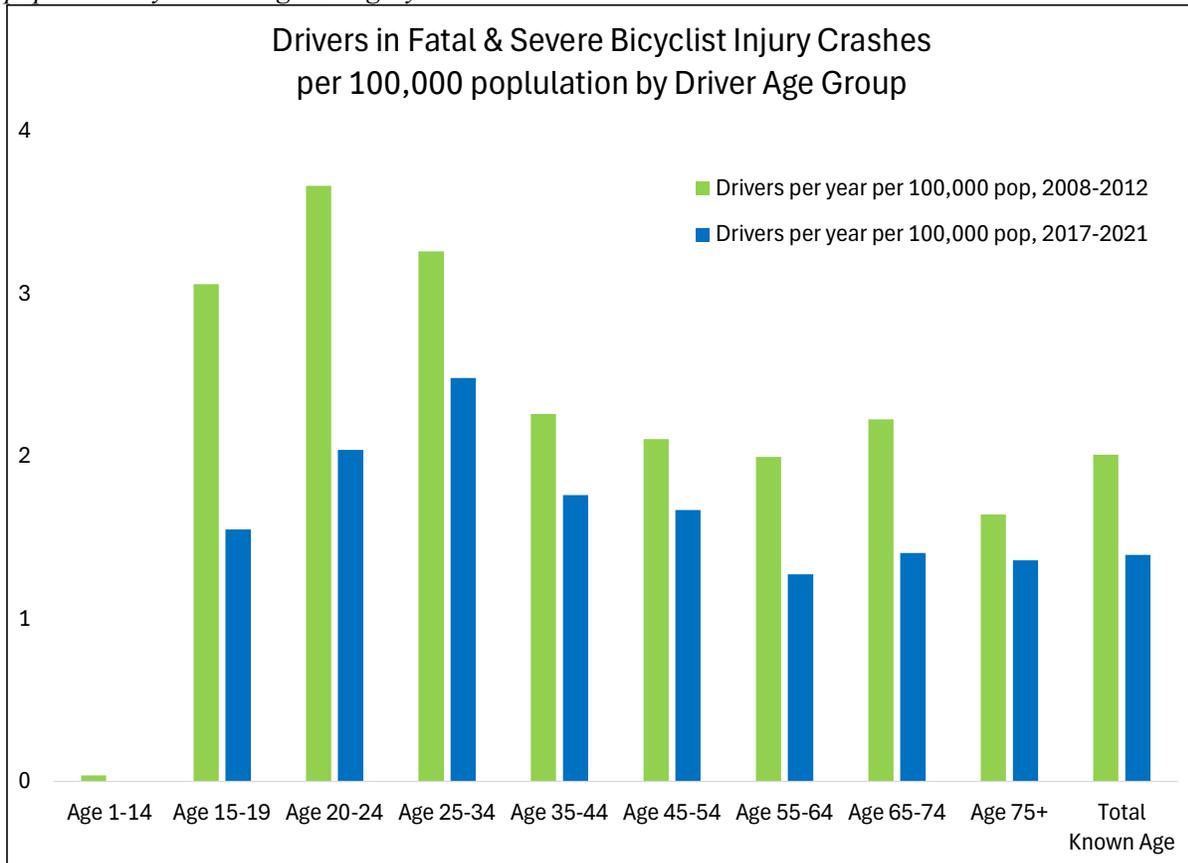


Figure 9. Wisconsin Fatal and Severe Bicyclist Injuries per 100,000 Population by Age Category



The highest rates of drivers being involved in a crash that produced a fatal or severe bicyclist injury were the 20-24 and 25-34 age categories of drivers (Figure 10). All driver age categories experienced decreases in fatal and severe bicyclist injury rates between 2008-2012 and 2017-2021.

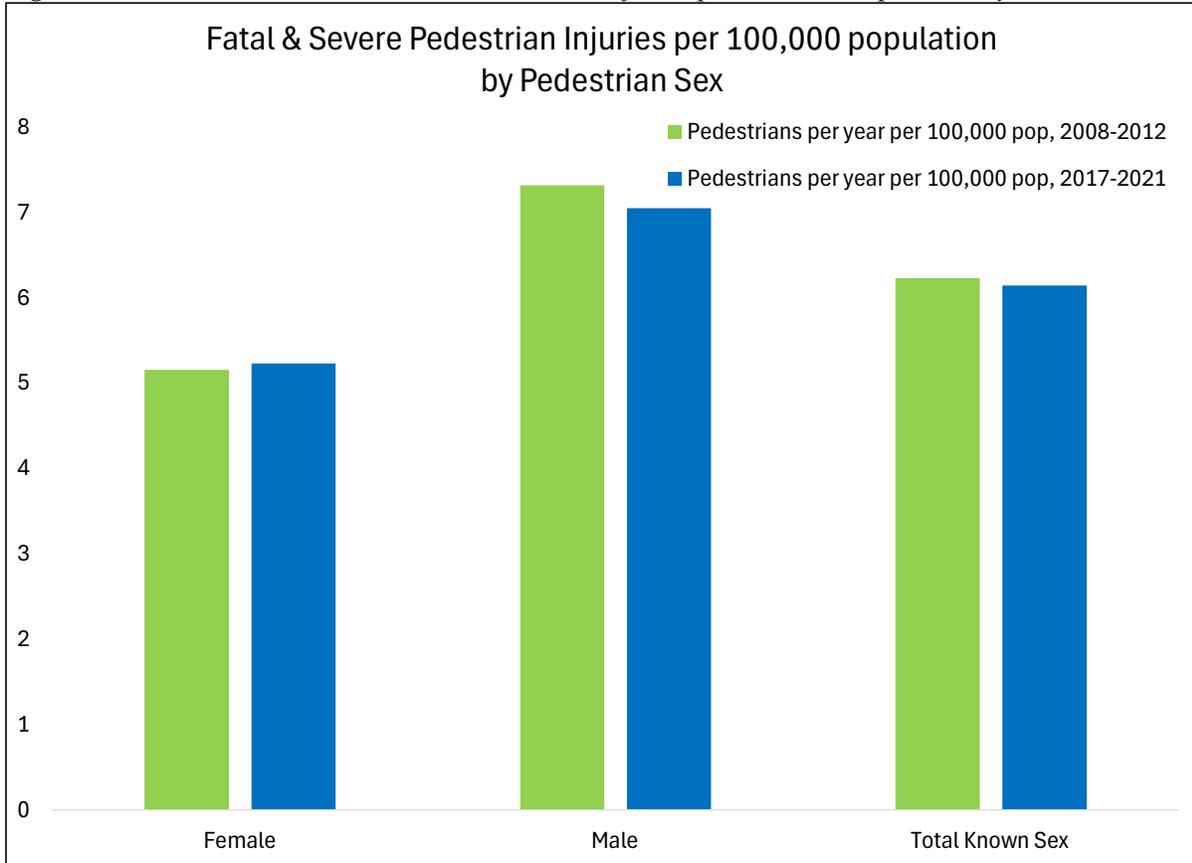
Figure 10. Drivers involved in Wisconsin Fatal or Severe Bicyclist Injury Crashes per 100,000 population by Driver Age Category



3.2.2. Sex

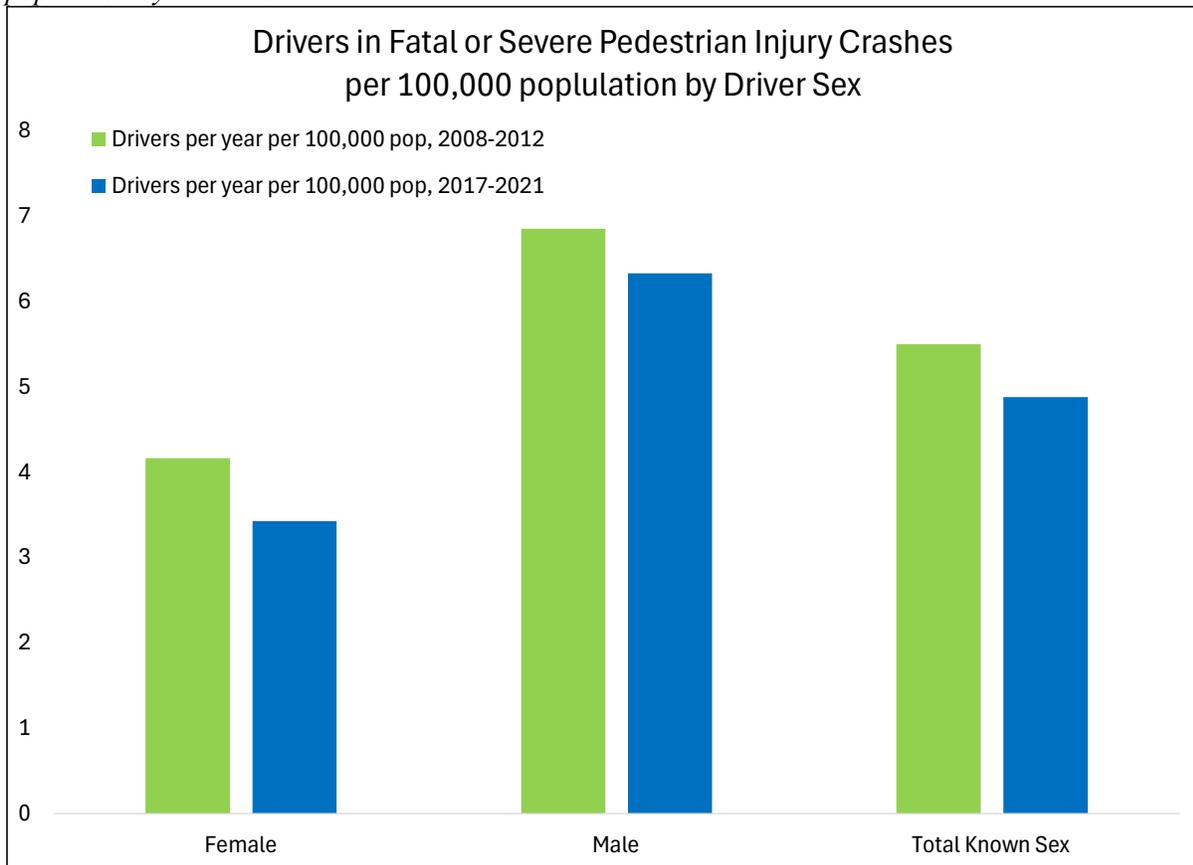
Among all pedestrians involved in crashes with a known sex, the rate of fatal and severe pedestrian injuries decreased from 6.23 to 6.14 per 100,000 population between 2008-2012 and 2017-2021 (Figure 11). Overall, males had higher rates of fatal and severe pedestrian injuries than females (7.32 versus 5.16 fatal and severe pedestrian injuries per 100,000 population in 2008-2012). However, this gap narrowed slightly between 2008-2012 and 2017-2021.

Figure 11. Wisconsin Fatal and Severe Pedestrian Injuries per 100,000 Population by Sex



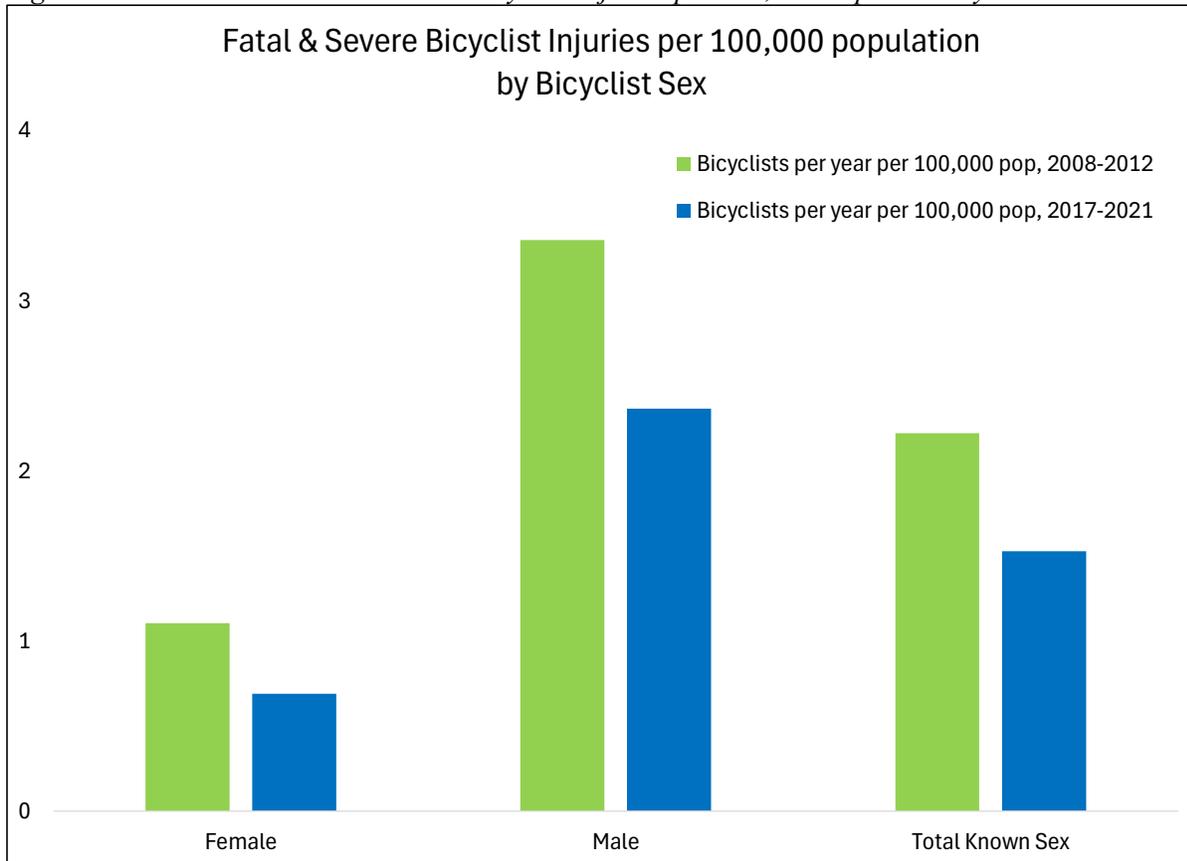
Drivers involved in pedestrian crashes that produced a fatal or severe pedestrian injury were more likely to be male than female (Figure 12). Population-based crash rates for both male and female drivers in these types of pedestrian crashes reduced decreased for both males and females between 2008-2012 and 2017-2021.

Figure 12. Drivers involved in Wisconsin Fatal or Severe Pedestrian Injury Crashes per 100,000 population by Driver Sex



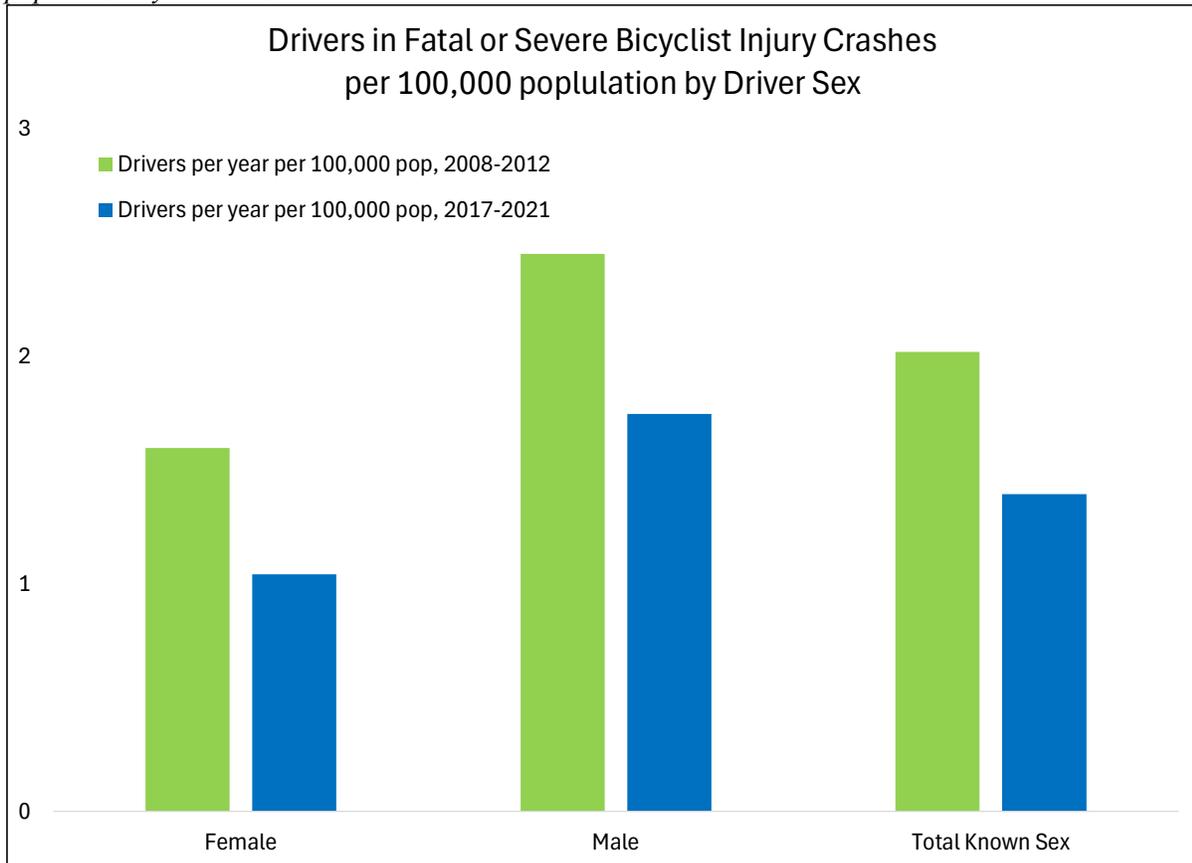
Among all bicyclists with a known sex, the rate of fatal and severe pedestrian injuries decreased from 2.22 to 1.53 per 100,000 population between 2008-2012 and 2017-2021 (Figure 13). Overall, males had higher rates of fatal and severe bicyclist injuries than females (3.35 versus 1.10 fatal and severe bicyclist injuries per 100,000 population in 2008-2012). Bicyclist injury rates decreased for both sexes between 2008-2012 and 2017-2021.

Figure 13. Wisconsin Fatal and Severe Bicyclist Injuries per 100,000 Population by Sex



Drivers involved in bicyclist crashes that produced a fatal or severe bicyclist injury were more likely to be male than female (Figure 14). Population-based crash rates for both male and female drivers in these types of bicyclist crashes reduced decreased between 2008-2012 and 2017-2021.

Figure 14. Drivers involved in Wisconsin Fatal or Severe Bicyclist Injury Crashes per 100,000 population by Driver Sex

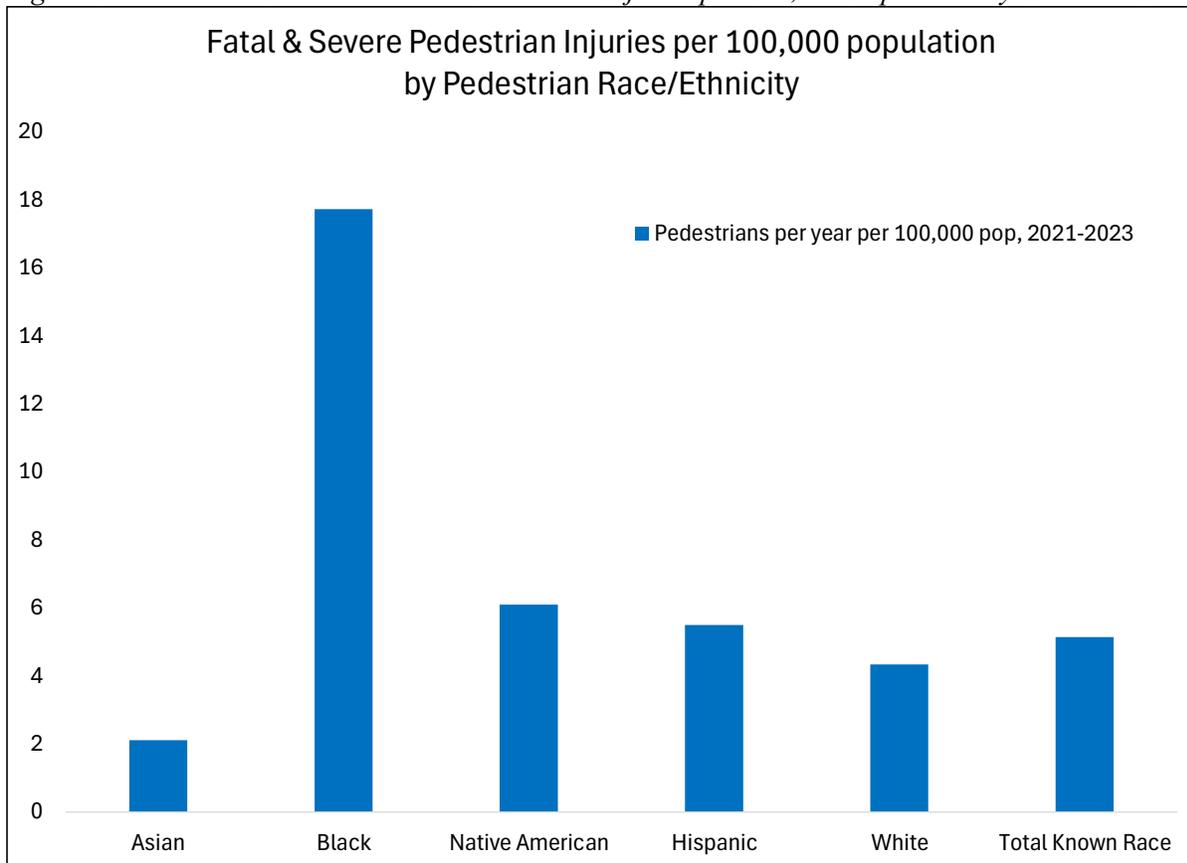


3.2.3. Race and Ethnicity

Race and ethnicity information has been recorded in Wisconsin crash reports since 2017 for drivers and since 2021 for pedestrians and bicyclists. Therefore, we only calculate injury rates by race for one time period, rather than comparing rates between two time periods around 2010 and 2020.

People who are Black had the highest rates of fatal and severe pedestrian injuries during the 2021-2023 period (Figure 15). The fatal and severe pedestrian injury rate per 100,000 population was 17.71 for Black residents compared to 6.09 for Native American, 5.49 for Hispanic, 4.34 for White, and 2.11 for Asian residents.

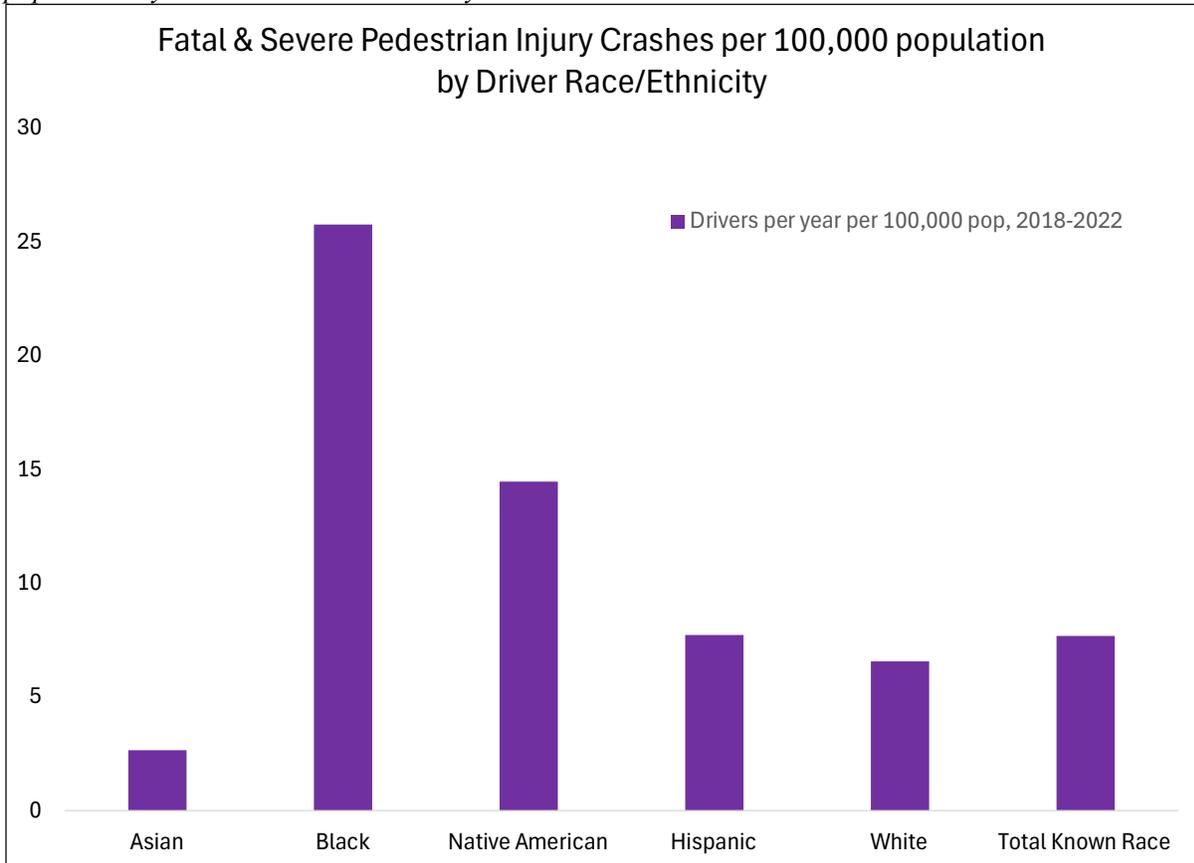
Figure 15. Wisconsin Fatal and Severe Pedestrian Injuries per 100,000 Population by Race and Ethnicity



Note that race/ethnicity information for pedestrians was not available from the Wisconsin crash database until 2021.

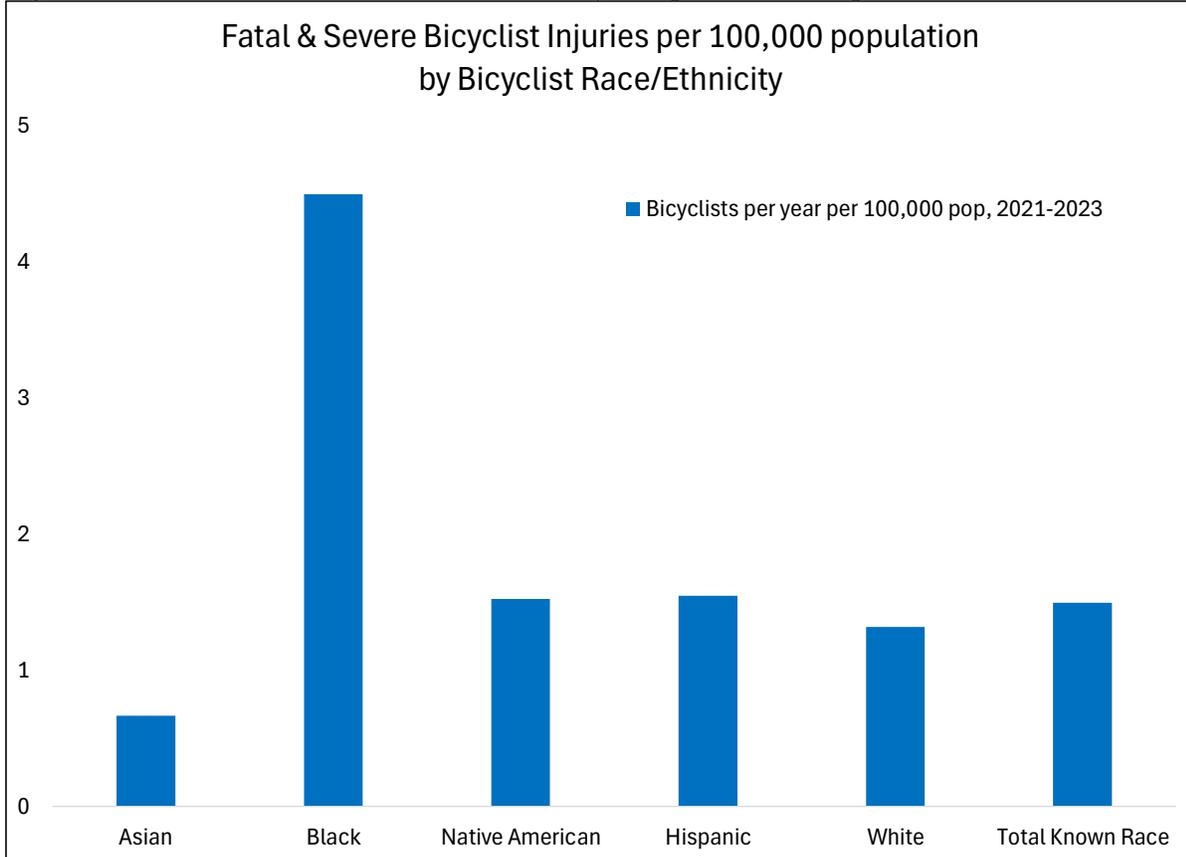
Drivers who were Black had higher rates of involvement in pedestrian crashes that produced a fatal or severe pedestrian injury than drivers of other races or ethnicities during 2018-2022 (Figure 16). Population-based crash rates for drivers by racial or ethnic group were highest for Black residents (25.78) followed by Native American (14.47), Hispanic (7.73), White (6.58), and Asian (2.67) residents.

Figure 16. Drivers involved in Wisconsin Fatal or Severe Pedestrian Injury Crashes per 100,000 population by Driver Race and Ethnicity



People who are Black had the highest rates of fatal and severe bicyclist injuries during the 2021-2023 period (Figure 17). The fatal and severe bicyclist injury rate per 100,000 population was 4.50 for Black residents compared to 1.55 for Hispanic, 1.52 for Native American, 1.32 for White, and 0.67 for Asian residents.

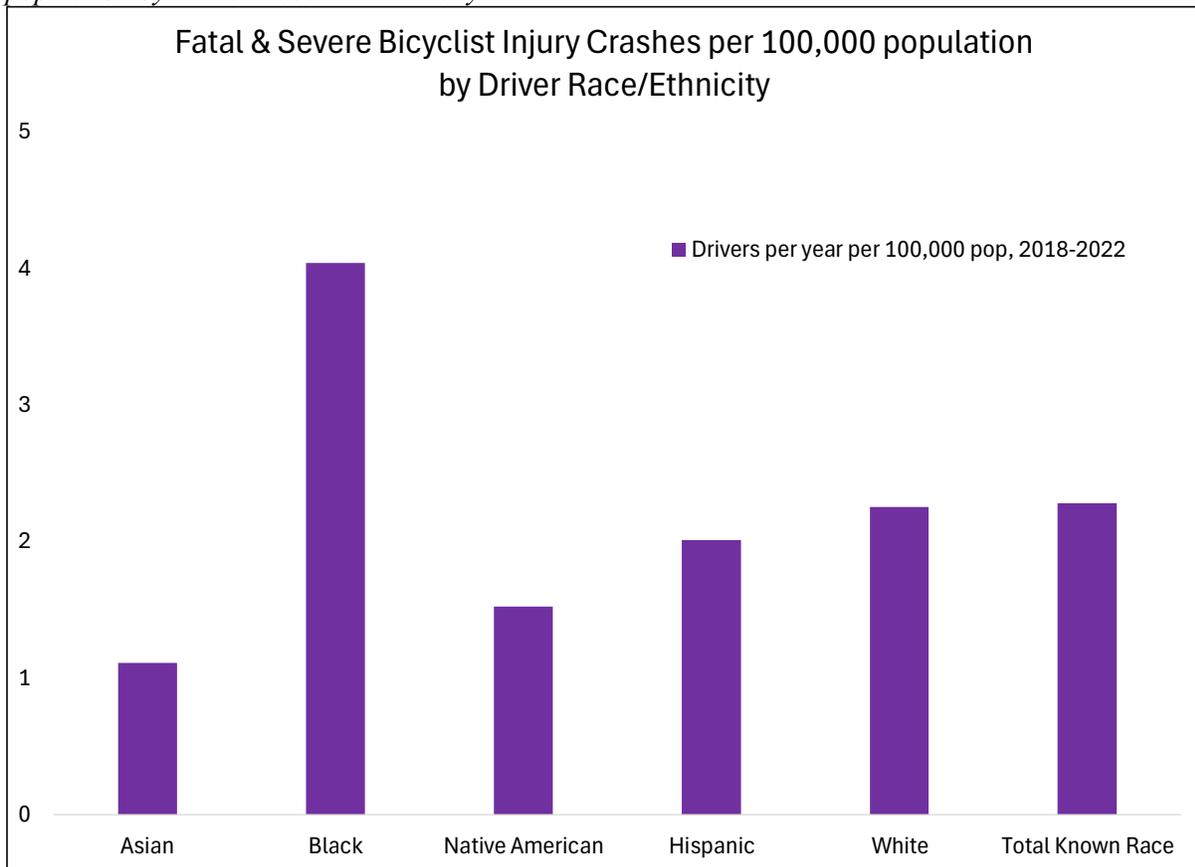
Figure 17. Wisconsin Fatal and Severe Bicyclist Injuries per 100,000 Population by Race and Ethnicity



Note that race/ethnicity information for bicyclists was not available from the Wisconsin crash database until 2021.

Drivers who were Black had higher rates of involvement in bicyclist crashes that produced a fatal or severe bicyclist injury than drivers of other races or ethnicities during 2018-2022 (Figure 18). Population-based crash rates for drivers by racial or ethnic group were highest for Black residents (4.04) followed by White (2.25), Hispanic (2.01), Native American (1.52), and Asian (1.11) residents.

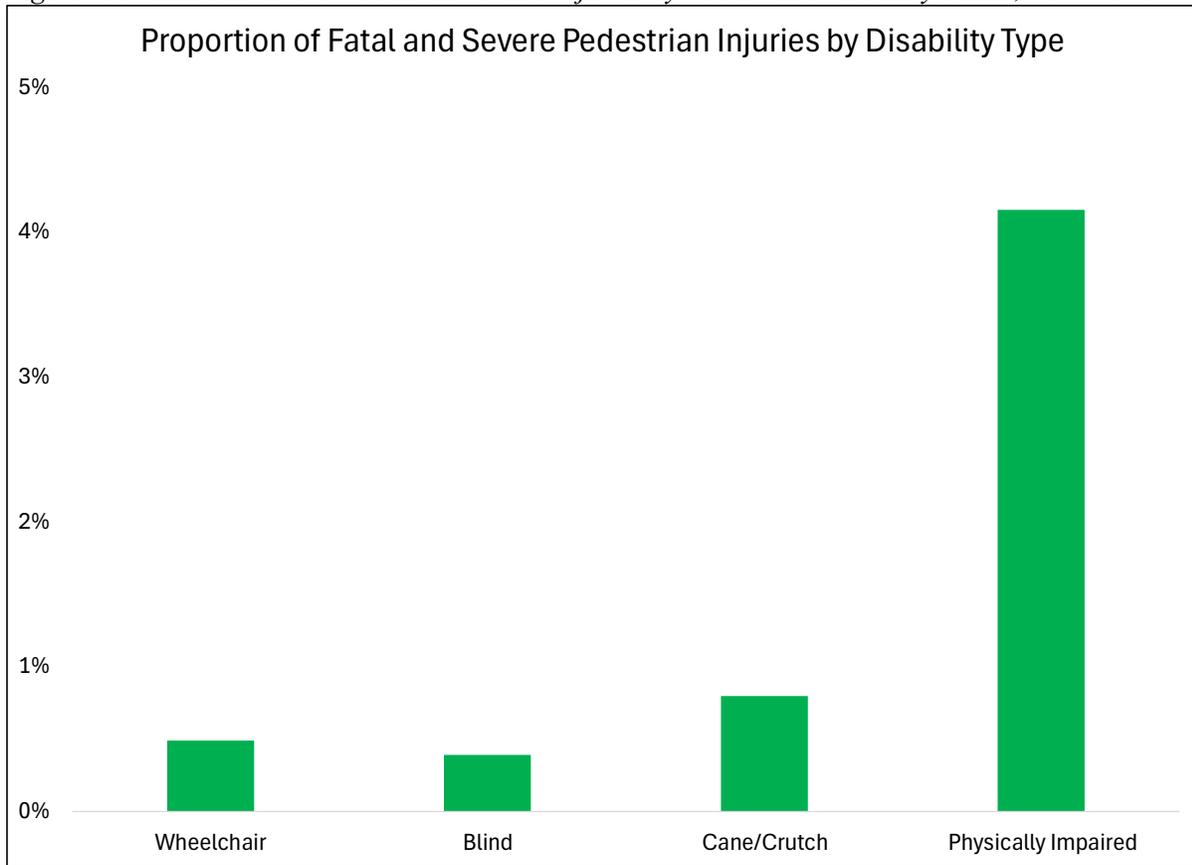
Figure 18. Drivers involved in Wisconsin Fatal or Severe Bicyclist Injury Crashes per 100,000 population by Driver Race and Ethnicity



3.2.4. Disabilities

Wisconsin crash reports have included the disability status of pedestrians and other parties involved in crashes since 2017. According to the American Community Survey five-year estimates for 2019-2023 (US Census Bureau 2025), 12.0% of Wisconsin's population has some type of disability. More specifically, 5.7% of the population age 5 or older has an ambulatory disability and 1.8% of the total population has a vision disability. Of all fatal and severe pedestrian injury crashes, more than 5% involved a pedestrian with some type of disability (Figure 19). Specifically, 4.2% involved a pedestrian with a physical impairment, 0.8% with a cane or crutch, 0.5% with a wheelchair, and 0.4% who was blind.

Figure 19. Fatal and Severe Pedestrian Crash Injuries by Pedestrian Disability Status, 2017-2023



3.3. Vehicle Type Shifts in Wisconsin Fatal and Serious Pedestrian and Bicyclist Injuries

We also examined the vehicle types involved in Wisconsin fatal and severe pedestrian and bicyclist injury crashes. Wisconsin crash reports have historically included the types of vehicles involved in crashes. However, more detailed vehicle type categories have been recorded since 2017, so we summarize the vehicles involved in pedestrian and bicyclist crashes since 2017.

Between 2017 and 2023, the most common vehicle type involved in fatal or severe pedestrian crashes (Figure 20) and fatal or severe bicyclist injury crashes (Figure 21) was passenger car. This is the most common vehicle type in Wisconsin's transportation system. Since 2017, there have been small fluctuations in the vehicle types involved in these types of crashes. The most noteworthy change is the decrease in the proportion of passenger cars and increase in the proportion of sport utility vehicles involved in fatal and severe bicyclist injury crashes during this time period.

Figure 20. Fatal and Severe Pedestrian Crash Injuries by Vehicle Type, 2017-2023

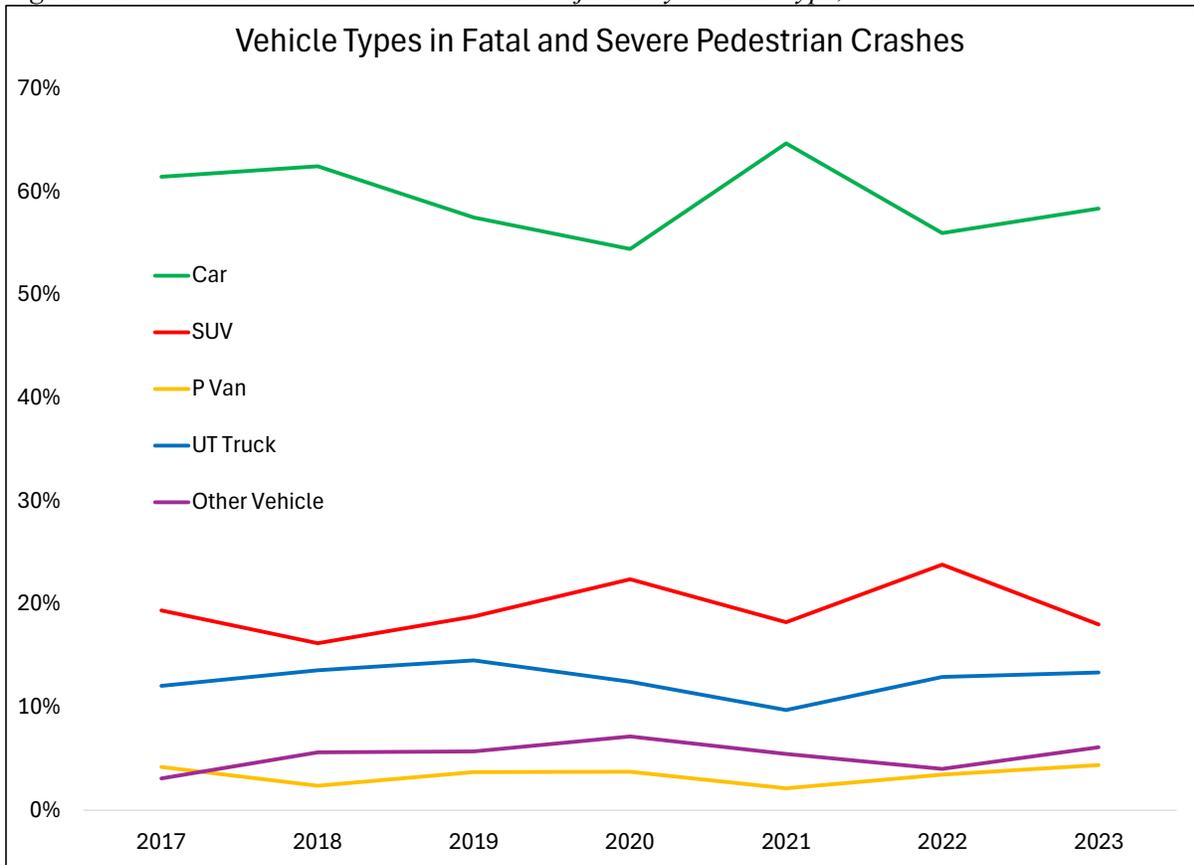
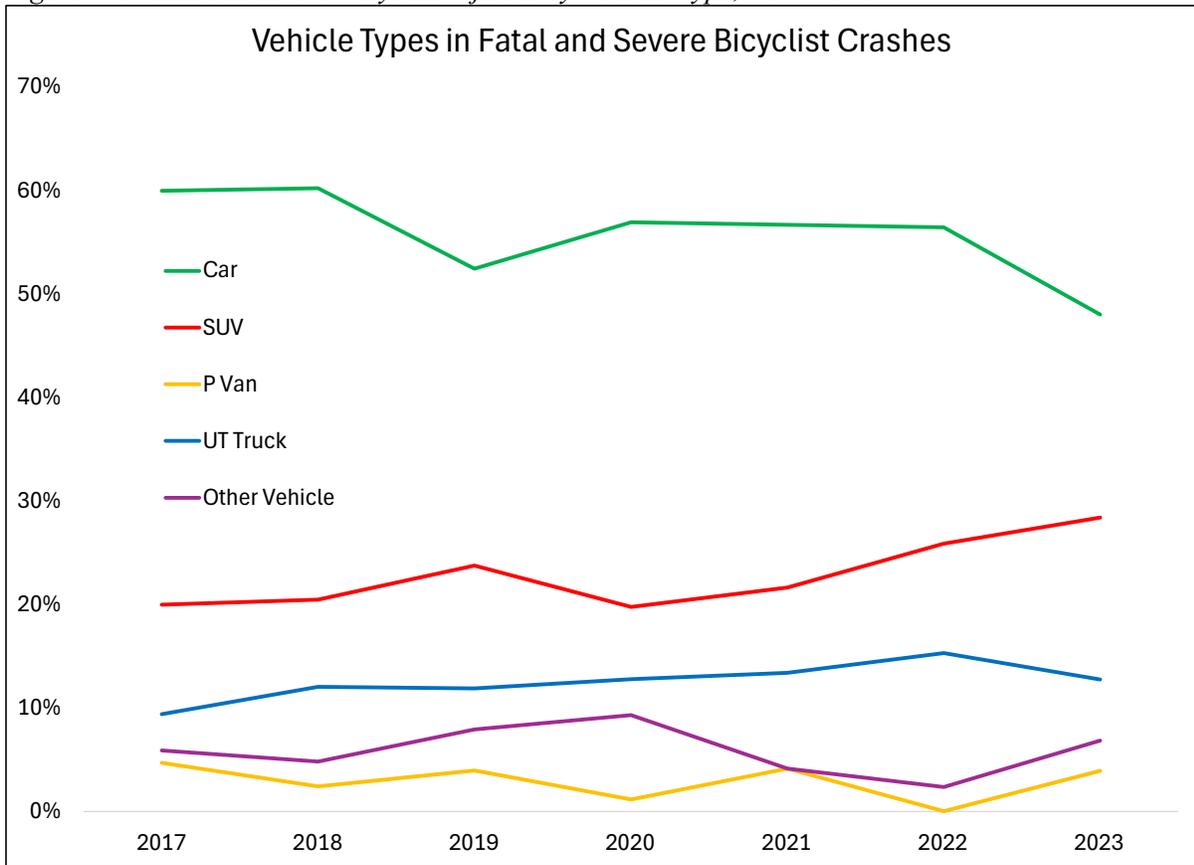


Figure 21. Fatal and Severe Bicyclist Injuries by Vehicle Type, 2017-2023



3.4. Geographic Shifts in Pedestrian and Bicyclist Injuries

We geocoded all pedestrian FSI and bicyclist FSI crashes in eight states, including Wisconsin, so that we could conduct several types of geographic analysis.⁶ This section describes our area-based analyses, including urbanization level (urban, suburban, and rural), WisDOT region, city, census tract, and roadway corridor type. The last section describes a “hot spot” identification process and provides a link to a dynamic online Story Map that highlights pedestrian and bicyclist crash concentrations during different time periods since 2008. Appendix A and Appendix B present advanced methods to assess geographic shifts in pedestrian and bicyclist injuries.

3.4.1. Pedestrian and Bicyclist Injuries in Urban, Suburban, and Rural Areas

Our first geographic analysis provided a high-level comparison of pedestrian FSI and bicyclist FSI crashes reported in urban, suburban, and rural areas of Wisconsin. We used 2018-2022 American Community Survey population data at the census tract level to divide the state into “urban” (more than 2,000 people per square mile), “dense suburban” (1,000 to 2,000 people per square mile), “sparse suburban” (100 to 1,000 people per square mile), and “rural” (fewer than 100 people per square mile) area types. Then we compared the percentage of geocoded pedestrian FSI and bicyclist FSI crashes that occurred in each of these area types during 2008-2012 versus 2018-2022.

Overall, pedestrian FSI crashes were most common in urban area types with high population density in both time periods (Table 2). However, serious pedestrian crashes shifted slightly away from dense urban areas as well as rural areas toward suburban areas between 2008-2012 and 2018-2022. The combined proportion of pedestrian FSI crashes in the two suburban categories increased from 26% to 31% between these two time periods. This could reflect overall population shifts toward these suburban area types, increased pedestrian activity (exposure) in suburban area types, or riskier behaviors in suburban area types. Further research is needed to understand why these shifts may have occurred.

Table 2. Geocoded Pedestrian FSI Crashes by Area Type, 2008-2012 vs. 2018-2022

	2008-2012		2018-2022	
	Number	%	Number	%
All crash locations	1291	100.0%	1556	100.0%
Urban (>2000 pop/sq mi)	777	60.2%	919	59.1%
Dense Suburban (1000-2000 pop/sq mi)	114	8.8%	183	11.8%
Sparse Suburban (100-1000 pop/sq mi)	220	17.0%	298	19.2%
Rural (<100 pop/sq mi)	180	13.9%	156	10.0%

⁶ The eight states were: California, Colorado, Massachusetts, New York, Oregon, Pennsylvania, Washington, and Wisconsin.

Bicyclist FSI crashes were also most common in urban area types with high population density (Table 3). In contrast to pedestrian FSI crashes, bicyclist crashes shifted from less dense area types toward urban area types between 2008-2012 and 2018-2022.

Table 3. Geocoded Bicyclist FSI Crashes by Area Type, 2008-2012 vs. 2018-2022

	2008-2012		2018-2022	
	Number	%	Number	%
All crash locations	560	100.0%	432	100.0%
Urban (>2000 pop/sq mi)	300	53.6%	249	57.6%
Dense Suburban (1000-2000 pop/sq mi)	73	13.0%	49	11.3%
Sparse Suburban (100-1000 pop/sq mi)	121	21.6%	86	19.9%
Rural (<100 pop/sq mi)	66	11.8%	48	11.1%

3.4.2. Pedestrian and Bicyclist Injuries by WisDOT Region

The WisTransPortal database includes the WisDOT region in which each crash occurred, so we compared how pedestrian FSI and bicyclist FSI crashes shifted among regions between 2008-2012 and 2018-2022. Approximately half of all pedestrian FSI crashes occurred in the SE Region, 20% were in the SW Region, and 15% were in the NE Region (Table 4). The SE Region was the only region to experience an increase in pedestrian FSI crashes between 2008-2012 and 2018-2022. Its proportion of the statewide share increased from 46% to 51%.

Table 4. Pedestrian FSI Crashes by WisDOT Region, 2008-2012 vs. 2018-2022

	2008-2012		2018-2022	
	Number	%	Number	%
SE	757	46.4%	803	50.6%
SW	342	21.0%	324	20.4%
NE	251	15.4%	232	14.6%
NW	154	9.4%	120	7.6%
NC	128	7.8%	109	6.9%
Total	1632	100.0%	1588	100.0%

Bicyclist FSI crashes were spread more evenly across the state. The largest number of bicyclist FSI crashes were still in the SE Region, but more than 25% were in the SW Region, and approximately 20% were in the NE Region (Table 5). Still, while bicyclist crashes decreased in all regions, the proportion of bicyclist crashes occurring in the SE Region increased from 35% to 39%.

Table 5. Bicyclist FSI Crashes by WisDOT Region, 2008-2012 vs. 2018-2022

	2008-2012		2018-2022	
	Number	%	Number	%
SE	214	34.7%	171	38.8%
SW	165	26.8%	115	26.1%
NE	131	21.3%	90	20.4%
NW	50	8.1%	31	7.0%
NC	56	9.1%	34	7.7%
Total	616	100.0%	441	100.0%

3.4.3. City-Level Analysis of Pedestrian and Bicyclist Injuries

We compared the raw numbers of crashes that occurred in 2008-2012 versus 2017-2021 within individual Wisconsin cities and villages. We measured the raw numbers of crashes and crash rates. In this section, we used two measures of exposure to represent pedestrian and bicyclist activity levels in each city: 1) total population and 2) estimated numbers of workers who commuted regularly by walking or bicycling from the American Community Survey (Table 6). Note that some smaller cities have high variability in crash rates between time periods due to their small numbers of reported crashes.

Table 6. Population and Transportation Mode to Work Data for Wisconsin and its 20 Largest Cities

	2010 Census Population	2012 5-Year Estimate ACS B08301: Means of Transportation to Work		2020 Census Population	2021 5-Year Estimate ACS B08301: Means of Transportation to Work	
		Walk	Bicycle		Walk	Bicycle
Statewide	5,686,986	92,860	21,098	5,893,718	84,307	16,181
Top 20 Cities (all)	1,888,451	40,156	12,729	1,935,151	37,556	9,960
Rest of State	3,798,535	52,704	8,369	3,958,567	46,751	6,221
Milwaukee	594,833	12,668	2,151	577,222	10,589	1,529
Madison	233,209	12,082	6,793	269,840	13,736	5,501
Green Bay	104,057	1,493	313	107,395	1,232	115
Kenosha	99,218	857	158	99,986	795	227
Racine	78,860	824	89	77,816	486	73
Appleton	72,623	1,391	399	75,644	1,441	234
Waukesha	70,718	1,311	176	71,158	1,243	72
Eau Claire	65,883	1,884	389	69,421	1,271	380
Oshkosh	66,083	1,376	380	66,816	1,265	339
Janesville	63,575	492	95	65,615	294	154
West Allis	60,411	459	70	60,325	500	99
La Crosse	51,320	2,210	701	52,680	1,972	402
Sheboygan	49,288	666	262	49,929	582	277
Wauwatosa	46,396	574	147	48,387	621	143
Fond du Lac	43,021	700	258	44,678	536	138
Brookfield	37,920	145	33	41,464	83	110
New Berlin	39,584	39	70	40,451	54	14
Wausau	39,106	618	190	39,994	476	112
Menomonee Falls	35,626	206	0	38,527	164	23
Greenfield	36,720	161	55	37,803	216	18

One advantage of using ACS pedestrian and bicycle commuter data is that they are collected consistently and available in all communities. This measure is also likely to be correlated with overall pedestrian and bicyclist activity within a city. Yet, it is an imperfect measure of exposure because work commute numbers do not capture people who occasionally walk or bicycle to work, walk or bicycle to public transit as a part of their commute, or make pedestrian or bicycle trips for other reasons (e.g., recreational, shopping, or social purposes).

3.4.3.1 City-Level Analysis of Pedestrian Injuries

Statewide, there was a 2.5% decrease in pedestrian FSI crashes between 2008-2012 and 2017-2021 (Table 7). However, Wisconsin's 20 largest cities actually experienced a 7.4% increase in pedestrian FSI crashes during this time. While some cities, such as Eau Claire, Brookfield and New Berlin, experienced decreases of more than 50%, other cities such West Allis, Sheboygan, Wauwatosa and Greenfield saw increases of 28% or more. Data from the two largest cities showed that Milwaukee increased by 24% while Madison increased by 7%.

Beyond these trends in raw numbers of pedestrian crashes, we analyzed crash rates using two exposure measures, population and walk to work commuters. Statewide, population increased but walking to work decreased between the two study periods. Some cities such as Appleton, Waukesha and Eau Claire saw fairly even decreases across all three categories. Other cities, such as Sheboygan and Wauwatosa's raw crash increase can be explained by increases in population and walk to work commuters. Madison experienced increase in raw crashes but its crash rates per population and per walk commuter decreased.

Table 7. Percent change in City Pedestrian FSI Crashes and Crash Rates from 2008-2012 to 2017-2021

FSI Pedestrian Crashes									
	RAW CRASHES			CRASH RATE PER 1000 POPULATION			CRASH RATE PER 1000 WALK TO WORK COMMUTERS		
	2008 to 2012	2017 to 2021	Percent Change	2008 to 2012	2017 to 2021	Percent Change	2008 to 2012	2017 to 2021	Percent Change
Statewide	1632	1592	-2.45%	0.29	0.27	-5.87%	17.57	18.88	7.45%
Largest 20 Cities	840	902	7.38%	0.44	0.47	4.79%	20.92	24.02	14.81%
Rest of State	792	690	-12.88%	0.21	0.17	-16.40%	15.03	14.76	-1.79%
Milwaukee	341	424	24.34%	0.57	0.73	28.13%	26.92	40.04	48.75%
Madison	99	106	7.07%	0.42	0.39	-7.46%	8.19	7.72	-5.82%
Green Bay	43	40	-6.98%	0.41	0.37	-9.87%	28.80	32.47	12.73%
Kenosha	45	40	-11.11%	0.45	0.40	-11.79%	52.51	50.31	-4.18%
Racine	46	46	0.00%	0.58	0.59	1.34%	55.83	94.65	69.55%
Appleton	20	15	-25.00%	0.28	0.20	-28.00%	14.38	10.41	-27.60%
Waukesha	32	17	-46.88%	0.45	0.24	-47.20%	24.41	13.68	-43.97%
Eau Claire	27	12	-55.56%	0.41	0.17	-57.82%	14.33	9.44	-34.12%
Oshkosh	20	18	-10.00%	0.30	0.27	-10.99%	14.53	14.23	-2.10%
Janesville	15	13	-13.33%	0.24	0.20	-16.03%	30.49	44.22	45.03%
West Allis	30	42	40.00%	0.50	0.70	40.20%	65.36	84.00	28.52%
La Crosse	29	30	3.45%	0.57	0.57	0.78%	13.12	15.21	15.93%
Sheboygan	14	19	35.71%	0.28	0.38	33.97%	21.02	32.65	55.30%
Wauwatosa	14	18	28.57%	0.30	0.37	23.28%	24.39	28.99	18.84%
Fond du Lac	19	21	10.53%	0.44	0.47	6.43%	27.14	39.18	44.34%
Brookfield	13	6	-53.85%	0.34	0.14	-57.79%	89.66	72.29	-19.37%
New Berlin	7	3	-57.14%	0.18	0.07	-58.06%	179.49	55.56	-69.05%
Wausau	10	10	0.00%	0.26	0.25	-2.22%	16.18	21.01	29.83%
Menomonee Falls	4	4	0.00%	0.11	0.10	-7.53%	19.42	24.39	25.61%
Greenfield	12	18	50.00%	0.33	0.48	45.70%	74.53	83.33	11.81%

Red and orange cells indicate the greatest percentage increases; green and yellow cells indicate the greatest percentage decreases.

We also explored how pedestrian injury severity changed within Wisconsin cities by analyzing three-year periods from 2008-2022. In general, proportions of the most severe injury crashes (K and A severity levels) increased over time in Milwaukee (Table 8), Madison (Table 9), Green Bay (Table 10), and Kenosha (Table 11). Due to smaller sample sizes, the next 16 largest cities were combined, but they also show a similar trend (Table 12). This indicates that pedestrian crashes have shifted to become more severe since 2008 in cities across Wisconsin. Many factors could be involved, but the data emphasizes that a focus should remain on reducing crashes that result in fatalities or severe injuries. Property-damage-only (O Level) crashes are not displayed in the tables but are included in the total crash counts.

Table 8. Pedestrian Crashes by Injury Severity Level over 3-year periods, Milwaukee

	2008 to 2010		2011 to 2013		2014 to 2016		2017 to 2019		2020 to 2022	
Total Crashes	1366		1418		1360		1382		1131	
Injury Severity	Crashes	% of Total								
K	30	2.20%	31	2.19%	46	3.38%	47	3.40%	57	5.04%
A	175	12.81%	173	12.20%	152	11.18%	208	15.05%	194	17.15%
B	542	39.68%	503	35.47%	516	37.94%	555	40.16%	464	41.03%
C	541	39.60%	621	43.79%	575	42.28%	466	33.72%	322	28.47%

Table 9. Pedestrian Crashes by Injury Severity Level over 3-year periods, Madison

	2008 to 2010		2011 to 2013		2014 to 2016		2017 to 2019		2020 to 2022	
Total Crashes	325		322		301		340		213	
Injury Severity	Crashes	% of Total								
K	10	3.08%	8	2.48%	11	3.65%	7	2.06%	9	4.23%
A	55	16.92%	43	13.35%	44	14.62%	64	18.82%	45	21.13%
B	146	44.92%	143	44.41%	140	46.51%	162	47.65%	93	43.66%
C	105	32.31%	111	34.47%	91	30.23%	79	23.24%	49	23.00%

Table 10. Pedestrian Crashes by Injury Severity Level over 3-year periods, Green Bay

	2008to2010		2011to2013		2014to2016		2017to2019		2020to2022	
Total Crashes	142		122		127		109		84	
Injury Severity	Crashes	% of Total								
K	1	0.70%	3	2.46%	1	0.79%	3	2.75%	2	2.38%
A	22	15.49%	21	17.21%	25	19.69%	19	17.43%	22	26.19%
B	58	40.85%	54	44.26%	47	37.01%	68	62.39%	40	47.62%
C	58	40.85%	42	34.43%	48	37.80%	19	17.43%	20	23.81%

Table 11. Pedestrian Crashes by Injury Severity Level over 3-year periods, Kenosha

	2008 to 2010		2011 to 2013		2014 to 2016		2017 to 2019		2020 to 2022	
Total Crashes	147		119		181		130		92	
Injury Severity	Crashes	% of Total								
K	4	2.72%	4	3.36%	1	0.55%	5	3.85%	2	2.17%
A	27	18.37%	17	14.29%	25	13.81%	23	17.69%	20	21.74%
B	62	42.18%	65	54.62%	91	50.28%	70	53.85%	45	48.91%
C	50	34.01%	29	24.37%	56	30.94%	29	22.31%	21	22.83%

Table 12. Pedestrian Crashes by Injury Severity Level over 3-year periods, next 16 Largest Cities

	2008 to 2010		2011 to 2013		2014 to 2016		2017 to 2019		2020 to 2022	
Total Crashes	981		997		1044		953		748	
Injury Severity	Crashes	% of Total								
K	19	1.94%	25	2.51%	21	2.01%	25	2.62%	25	3.34%
A	161	16.41%	161	16.15%	161	15.42%	163	17.10%	145	19.39%
B	440	44.85%	429	43.03%	453	43.39%	491	51.52%	372	49.73%
C	332	33.84%	355	35.61%	366	35.06%	235	24.66%	164	21.93%

3.4.3.2 City-Level Analysis of Bicycle Injuries

Similar to pedestrian crashes, raw numbers of statewide bicyclist FSI crashes decreased between 2008-2012 and 2017-2021 (Table 13). Statewide, as well as the largest 20 cities, experienced a nearly 30% decrease in raw crashes. A few cities, such as Racine and West Allis, experienced increases, but most other cities had varying degrees of decrease over the two time periods.

Overall, the state experienced a decrease in crash rate per 1000 population. However, the decrease per 1000 bike commuters was less pronounced, indicating that some of the decreases in raw bicyclist FSI crashes could be due to lower levels of bicycling to work during the later study period. Note that bicycle commuting data does not account for recreational bicycling, so other exposure variables are needed to represent how overall levels of bicyclist activity are changing over time.

Table 13. Percent change in City Bicyclist FSI crashes and crash rates from 2008-2012 to 2017-2021

FSI Bicycle Crashes									
	RAW CRASHES			CRASH RATE PER 1000 POPULATION			CRASH RATE PER 1000 BIKE TO WORK COMMUTERS		
	2008 to 2012	2017 to 2021	Percent Change	2008 to 2012	2017 to 2021	Percent Change	2008 to 2012	2017 to 2021	Percent Change
Statewide	616	442	-28.25%	0.11	0.07	-30.76%	29.20	27.32	-6.44%
Largest 20 Cities	299	211	-29.43%	0.16	0.11	-31.13%	23.28	21.18	-9.02%
Rest of State	317	231	-27.13%	0.08	0.06	-30.08%	37.88	37.13	-1.97%
Milwaukee	53	51	-3.77%	0.09	0.09	-0.84%	24.64	33.36	35.37%
Madison	63	40	-36.51%	0.27	0.15	-45.13%	9.27	7.27	-21.60%
Green Bay	13	6	-53.85%	0.12	0.06	-55.28%	41.53	52.17	25.62%
Kenosha	23	9	-60.87%	0.23	0.09	-61.17%	145.57	39.65	-72.76%
Racine	8	13	62.50%	0.10	0.17	64.68%	89.89	178.08	98.12%
Appleton	14	13	-7.14%	0.19	0.17	-10.85%	35.09	55.56	58.33%
Waukesha	9	4	-55.56%	0.13	0.06	-55.83%	51.14	55.56	8.64%
Eau Claire	12	7	-41.67%	0.18	0.10	-44.64%	30.85	18.42	-40.29%
Oshkosh	10	8	-20.00%	0.15	0.12	-20.88%	26.32	23.60	-10.32%
Janesville	8	3	-62.50%	0.13	0.05	-63.67%	84.21	19.48	-76.87%
West Allis	7	15	114.29%	0.12	0.25	114.59%	100.00	151.52	51.52%
La Crosse	21	9	-57.14%	0.41	0.17	-58.25%	29.96	22.39	-25.27%
Sheboygan	12	5	-58.33%	0.24	0.10	-58.87%	45.80	18.05	-60.59%
Wauwatosa	11	5	-54.55%	0.24	0.10	-56.42%	74.83	34.97	-53.27%
Fond du Lac	10	7	-30.00%	0.23	0.16	-32.60%	38.76	50.72	30.87%
Brookfield	6	2	-66.67%	0.16	0.05	-69.52%	181.82	18.18	-90.00%
New Berlin	3	1	-66.67%	0.08	0.02	-67.38%	42.86	71.43	66.67%
Wausau	10	6	-40.00%	0.26	0.15	-41.33%	52.63	53.57	1.79%
Menomonee Falls	2	3	50.00%	0.06	0.08	38.71%	N/A	130.43	N/A
Greenfield	4	4	0.00%	0.11	0.11	-2.86%	72.73	222.22	205.56%

Red and orange cells indicate the greatest percentage increases; green and yellow cells indicate the greatest percentage decreases.

The severity of bicyclist crashes shifted over time in Wisconsin’s 20 largest cities, as shown by our analysis of three-year periods from 2008 to 2022. In general, proportions of the most severe injury crashes (K and A severity levels) increased over time in Milwaukee (Table 14) and Madison (Table 15). Trends were less clear in Green Bay (Table 16) and Kenosha (Table 17). Due to smaller sample sizes, the next 16 largest cities were combined, and they trended toward having a greater proportion of bicyclist FSI crashes (Table 18). There are fewer bicyclist crashes than pedestrian crashes, so the percentages of crashes at each injury severity level are more variable over time. Property-damage-only (O Level) crashes are not displayed in the tables but are included in the total crash counts.

Table 14. Bicyclist Crashes by Injury Severity Level over 3-year periods, Milwaukee

	2008 to 2010		2011 to 2013		2014 to 2016		2017 to 2019		2020 to 2022	
Total Crashes	465		499		422		359		275	
Injury Severity	Crashes	% of Total								
K	1	0.22%	3	0.60%	2	0.47%	3	0.84%	9	3.27%
A	33	7.10%	28	5.61%	16	3.79%	29	8.08%	24	8.73%
B	176	37.85%	165	33.07%	146	34.60%	154	42.90%	111	40.36%
C	199	42.80%	239	47.90%	199	47.16%	113	31.48%	75	27.27%

Table 15. Bicyclist Crashes by Injury Severity Level over 3-year periods, Madison

	2008 to 2010		2011 to 2013		2014 to 2016		2017 to 2019		2020 to 2022	
Total Crashes	375		401		343		286		198	
Injury Severity	Crashes	% of Total								
K	1	0.27%	3	0.75%	2	0.58%	0	0.00%	4	2.02%
A	39	10.40%	27	6.73%	17	4.96%	23	8.04%	20	10.10%
B	180	48.00%	198	49.38%	170	49.56%	179	62.59%	121	61.11%
C	133	35.47%	125	31.17%	112	32.65%	52	18.18%	32	16.16%

Table 16. Bicyclist Crashes by Injury Severity Level over 3-year periods, Green Bay

	2008 to 2010		2011 to 2013		2014 to 2016		2017 to 2019		2020 to 2022	
Total Crashes	81		83		77		51		44	
Injury Severity	Crashes	% of Total								
K	1	1.23%	0	0.00%	0	0.00%	1	1.96%	1	2.27%
A	6	7.41%	8	9.64%	7	9.09%	3	5.88%	2	4.55%
B	39	48.15%	39	46.99%	33	42.86%	38	74.51%	25	56.82%
C	32	39.51%	36	43.37%	37	48.05%	9	17.65%	16	36.36%

Table 17. Bicyclist Crashes by Injury Severity Level over 3-year periods, Kenosha

	2008 to 2010		2011 to 2013		2014 to 2016		2017 to 2019		2020 to 2022	
Total Crashes	107		98		96		79		59	
Injury Severity	Crashes	% of Total								
K	0	0.00%	1	1.02%	1	1.04%	1	1.27%	0	0.00%
A	13	12.15%	11	11.22%	11	11.46%	4	5.06%	4	6.78%
B	55	51.40%	57	58.16%	42	43.75%	40	50.63%	34	57.63%
C	36	33.64%	26	26.53%	37	38.54%	23	29.11%	15	25.42%

Table 18. Bicyclist Crashes by Injury Severity Level over 3-year periods, next 16 Largest Cities

	2008 to 2010		2011 to 2013		2014 to 2016		2017 to 2019		2020 to 2022	
Total Crashes	917		944		841		694		505	
Injury Severity	Crashes	% of Total								
K	9	0.98%	11	1.17%	12	1.43%	9	1.30%	11	2.18%
A	85	9.27%	71	7.52%	64	7.61%	59	8.50%	64	12.67%
B	485	52.89%	512	54.24%	464	55.17%	381	54.90%	270	53.47%
C	306	33.37%	301	31.89%	252	29.96%	188	27.09%	114	22.57%

3.4.4. Census Tract Characteristics associated with Pedestrian FSI and Bicyclist FSI Crashes

We analyzed pedestrian FSI and bicyclist FSI crashes within census tracts to explore how these serious crashes shifted at the neighborhood level between a five-year baseline period (2008-2012) and five-year later period (2017-2021). We examined how these shifts related to socioeconomic characteristics, roadway characteristics, population and job densities, transit stop proximity, and other variables using negative binomial models. The eight-state models also include state dummy variables that control for state-level variations in crash reporting practices, policies, culture, or other factors that are not included directly in the model. Our analyses compare geographic shifts in crashes across all eight states (21,833 census tracts) and Wisconsin only (1,372 census tracts). A small proportion of tracts without reported household income data were excluded.

The first subsection below summarizes census tract characteristics associated with pedestrian FSI crashes in the baseline period and how these characteristics shifted between the baseline and later period. The second subsection summarizes census tract characteristics associated with bicyclist FSI crashes and how they shifted over time.

3.4.4.1. Census Tract Characteristics Associated with Pedestrian FSI Crashes

During the baseline period (2008-2012), pedestrian FSI crashes tended to occur in locations with characteristics related to more walking activity, as indicated by exposure variables with exponentiated coefficients greater than one in our models (Table 19). Census tracts with more people, more jobs, more regular public transit commuters, and more regular walk commuters had a higher likelihood of pedestrian FSI crashes. This was found across all eight states and in Wisconsin only (though the percent of public transit commuters was not statistically significant in the Wisconsin model). After controlling for exposure, pedestrian FSI crashes across all eight states were associated with neighborhoods that have higher shares of Black residents, higher shares of Hispanic residents, lower median incomes, higher shares of unemployed workers, higher proportions of retail jobs, higher population density, close proximity to transit stops, an interstate highway, and at least one arterial roadway with volume higher than 20,000 Annualized Average Daily Traffic (AADT). Within Wisconsin, the percent of Hispanic residents, median income, transit stop proximity, and arterial roadways with more than 20,000 AADT variables were statistically significant, and these relationships were in a consistent direction with what we found across the eight-states as a whole.

The models for the later period (2017-2021) showed statistically significant relationships in the same direction as the baseline period across all eight states (with the exception of employment density) and in

Wisconsin. In Wisconsin, the variables for share of public transit commuters, share of Black residents, and proportion of retail jobs also became statistically significant in the later period.

Comparing the coefficients of the baseline period (2008-2012) and later period (2017-2021) models, we found statistically significant shifts in the association between several tract-level characteristics and pedestrian FSI crashes. Across all eight states, total jobs had a stronger relationship with pedestrian FSI crashes but total population and percent transit commuters had a weaker relationship with pedestrian FSI crashes in the later period. After considering these exposure shifts, pedestrian FSI crashes became even more strongly associated with the share of Black residents, share of Hispanic residents, proportion of retail jobs, interstate highways, and other freeways and expressways across all eight states. Tracts with lower median income and higher employment density became more weakly associated with pedestrian FSI crashes (employment density actually switched from a positive to negative relationship with pedestrian FSI crashes). Within Wisconsin, the only significant shifts were a stronger positive relationship between total jobs and pedestrian FSI crashes and weaker positive relationship between lower median income and pedestrian FSI crashes.

Table 19. Models of Pedestrian FSI Crashes per Census Tract, 2008-2012 vs. 2017-2021

	Association between Tract Characteristics and Number of Pedestrian FSI Crashes in a Five-Year Period ¹								Significant Shifts ²	
	Baseline Period (2008-2012)				Later Period (2017-2021)					
	Eight States		Wisconsin		Eight States		Wisconsin		Eight States Later vs. Baseline	Wisconsin Later vs. Baseline
	Exp(β)	Sig.	Exp(β)	Sig.	Exp(β)	Sig.	Exp(β)	Sig.		
Constant	0.638	**	0.662		0.656	**	0.508	**		
Exposure Variables										
Total Population (000s)	1.114	**	1.143	**	1.055	**	1.075	**	--	
Total Jobs (000s)	1.027	**	1.038	**	1.035	**	1.085	**	++	+
% Transit	3.691	**	6.450		1.895	**	33.191	**	--	
% Walk	5.050	**	5.675	*	6.117	**	1.604			
Socioeconomic Variables³										
% Black	1.278	**	1.506		2.415	**	3.158	**	++	
% Hispanic	1.368	**	2.455	*	2.186	**	3.174	**	++	
Median Income (0000s)	0.929	**	0.887	**	0.977	**	0.957	**	++	++
% Unemployed	3.022	**	3.951		4.612	**	6.411			
Job Variables⁴										
% Retail	1.816	**	1.026		2.564	**	2.749	**	++	
Land Use Variables										
Population Density (000s) ⁵	0.389	**			0.875	**				
Employment Density (000s)	2.299	**	1.047		0.822	**	7.972		--	
Transit Nearby ⁶	1.320	**	1.286	*	1.380	**	1.311	*		
Roadway Characteristics⁷										
Interstate	1.054	**	0.966		1.142	**	1.044		++	
Other Fwy/Expressway	1.032		0.989		1.103		1.035		++	
Maximum AADT >20K	1.658	**	1.396	**	1.661	**	1.443	**		
State (base = California)⁷										
Colorado	0.885	**			1.086	**			++	
Massachusetts	1.102	**			0.843	**			--	
New York	1.450	**			1.033	**			--	
Oregon	0.712	**			0.757	**				
Pennsylvania	0.622	**			0.669	**				
Washington	1.002				1.023					
Wisconsin	0.886	**			0.785	**			-	
Overall model										
Log Likelihood	-39118		-2026		-42413		-2113			
AIC	78282		4082		84873		4255			
BIC	78466		4161		85057		4334			

- 1) The eight-state models are based on observations from 21,833 census tracts, and the Wisconsin models are based on observations from 1,372 tracts. Exp(β) presents the exponentiated form of the coefficient estimate. Values less than one indicate a negative relationship and values more than one indicate a positive relationship between the variable and the number of Pedestrian FSI crashes. Sig. indicates the statistical significance of the coefficient estimate: ** is $p < 0.01$; * is $p < 0.05$.
- 2) The Significant Shifts columns show the results of Z-tests of differences between each coefficient value in the baseline period and the corresponding coefficient value in the later period: "++" indicates that the later period coefficient is significantly larger with $p < 0.01$; "+" indicates that the later period coefficient is significantly larger with $p < 0.05$; "--" indicates that the later period coefficient is significantly smaller with $p < 0.01$; and "-" indicates that the later period coefficient is significantly smaller with $p < 0.05$.
- 3) Other variables tested but not included were Non-Hispanic white, Non-Hispanic Asian, and Non-Hispanic Native American.
- 4) Job variables are relative to all other job categories (e.g., industrial, service, entertainment).
- 5) The population density variable was removed from the Wisconsin model due to multicollinearity with other variables.
- 6) The transit nearby variable indicates that a transit stop is located within 0.75 miles of the center of the census tract.
- 7) Arterial with AADT >20K indicates that there is at least one roadway in the census tract (other than interstates, freeways, or expressways) with more than 20,000 AADT. The interstate, other freeway/expressway, and AADT variables have the same values in the baseline and later periods, but their relationships with Pedestrian FSI crashes in each period are different.

3.4.4.2. Census Tract Characteristics associated with Bicyclist FSI Crashes

During the baseline period (2008-2012), bicyclist FSI crashes tended to occur in census tracts with characteristics related to higher bicyclist exposure (Table 20). Census tracts with more people, more jobs, and more regular bicycle commuters had a higher likelihood of bicyclist FSI crashes. This was found across all eight states and in Wisconsin only. After controlling for exposure, bicyclist FSI crashes across all eight states were associated with neighborhoods that have higher shares of Black residents, lower median incomes, higher shares of unemployed workers, higher proportions of retail jobs, higher population density, higher employment density, close proximity to transit stops, and at least one arterial roadway with volume higher than 20,000 Annualized Average Daily Traffic (AADT). Within Wisconsin, the share of unemployed workers and arterial roadways with more than 20,000 AADT variables were statistically significant, and these relationships were in a consistent direction with what we found across the eight-states as a whole.

The models for the later period (2017-2021) showed statistically significant relationships in the same direction as the baseline period across all eight states, but the share of Hispanic residents and presence of a non-interstate freeway or expressway were also positively associated with bicyclist FSI crashes. In Wisconsin, total population and the share of unemployed workers lost statistical significance in the later period.

Comparing the coefficients of the baseline period (2008-2012) and later period (2017-2021) models, we found statistically significant shifts in the association between several tract-level characteristics and bicyclist FSI crashes. Across all eight states and in Wisconsin only, total population had a weaker relationship with bicyclist FSI crashes in the later period. After considering these exposure shifts, bicyclist FSI crashes across all eight states became even more strongly associated with the share of Black residents, share of Hispanic residents, higher population density, and the presence of a non-interstate freeway or expressway. Tracts with lower median income and with a transit stop nearby became more weakly associated with bicyclist FSI crashes across all eight states. Within Wisconsin only, there were no other significant shifts related to bicyclist FSI crashes per tract.

Table 20. Models of Bicyclist FSI Crashes per Census Tract, 2008-2012 vs. 2017-2021

	Association between Tract Characteristics and Number of Bicyclist FSI Crashes in a Five-Year Period ¹								Significant Shifts ²	
	Baseline Period (2008-2012)				Later Period (2017-2021)					
	Eight States		Wisconsin		Eight States		Wisconsin		Eight States Later vs. Baseline	Wisconsin Later vs. Baseline
	Exp(β)	Sig.	Exp(β)	Sig.	Exp(β)	Sig.	Exp(β)	Sig.		
Constant	0.282	**	0.163	**	0.324	**	0.233	**		
Exposure Variables										
Total Population (000s)	1.083	**	1.195	**	1.025	**	1.026		- -	- -
Total Jobs (000s)	1.027	**	1.043	**	1.027	**	1.060	**		
% Bicycle	20152	**	2113817	**	34611	**	648681	**		
Socioeconomic Variables³										
% Black	1.306	**	0.491		1.614	**	0.868		+	
% Hispanic	1.030		1.147		1.408	**	2.171		++	
Median Income (0000s)	0.978	**	0.950		0.995	**	0.981		++	
% Unemployed	1.931	*	59.409	**	3.059	**	3.865			
Job Variables⁴										
% Retail	1.387	**	0.803		1.403	**	1.109			
Land Use Variables										
Population Density (000s) ⁵	21.146	**			112.14	**			++	
Employment Density (000s)	3.745	**	0.095		2.514	**	0.399			
Transit Nearby ⁶	1.236	**	1.258		1.147	**	1.312		-	
Roadway Characteristics⁷										
Interstate	0.993		0.874		1.007		1.026			
Other Fwy/Expressway	1.028		1.047		1.140	**	1.169		++	
Maximum AADT >20K	1.425	**	1.345	**	1.369	**	1.344	*		
State (base = California)⁷										
Colorado	0.927				1.227	**			++	
Massachusetts	0.865	**			0.689	**			- -	
New York	1.388	**			1.144	**			- -	
Oregon	0.717	**			0.636	**				
Pennsylvania	0.293	**			0.368	**			++	
Washington	0.866	**			0.817	**				
Wisconsin	0.898	*			0.654	**			- -	
Overall model										
Log Likelihood	-23562		-1310		-24588		-1137			
AIC	47169		2647		49220		2302			
BIC	47345		2720		49396		2375			

1) The eight-state models are based on observations from 21,833 census tracts, and the Wisconsin models are based on observations from 1,372 tracts. Exp(β) presents the exponentiated form of the coefficient estimate. Values less than one indicate a negative relationship and values more than one indicate a positive relationship between the variable and the number of bicyclist FSI crashes. Sig. indicates the statistical significance of the coefficient estimate: ** is $p < 0.01$; * is $p < 0.05$.

2) The Significant Shifts columns show the results of Z-tests of differences between each coefficient value in the baseline period and the corresponding coefficient value in the later period: “++” indicates that the later period coefficient is significantly larger with $p < 0.01$; “+” indicates that the later period coefficient is significantly larger with $p < 0.05$; “- -” indicates that the later period coefficient is significantly smaller with $p < 0.01$; and “-” indicates that the later period coefficient is significantly smaller with $p < 0.05$.

3) Other variables tested but not included were Non-Hispanic white, Non-Hispanic Asian, and Non-Hispanic Native American.

4) Job variables are relative to all other job categories (e.g., industrial, service, entertainment).

5) The population density variable was removed from the Wisconsin model due to multicollinearity with other variables.

6) The transit nearby variable indicates that a transit stop is located within 0.75 miles of the center of the census tract.

7) Arterial with AADT >20K indicates that there is at least one roadway in the census tract (other than interstates, freeways, or expressways) with more than 20,000 AADT. The interstate, other freeway/expressway, and AADT variables have the same values in the baseline and later periods, but their relationships with Pedestrian FSI crashes in each period are different.

3.4.5. Roadway Types Associated with Pedestrian FSI and Bicyclist FSI Crashes

The WisTransPortal database includes the police-reported roadway functional classification of each crash location, so we compared how pedestrian FSI and bicyclist crashes shifted between types of roadways between 2008-2012 and 2018-2022. This analysis excluded crashes on parking lots or private property.

More than half of pedestrian FSI crashes were on urban city streets, which include local arterial and collector streets (Table 21). Approximately 21% were on urban state highways, which are typically high-traffic arterial streets in cities. Between 2008-2012 and 2018-2022, the proportion of pedestrian FSI crashes increased the most on urban city streets, increased slightly on urban state highways, and decreased on rural state highways.

Table 21. Pedestrian FSI Crashes by Roadway Type, 2008-2012 vs. 2018-2022

	2008-2012		2018-2022	
	Number	%	Number	%
Urban city street	726	53.5%	753	55.4%
Urban county trunk	0	0.0%	6	0.4%
Urban interstate highway	7	0.5%	25	1.8%
Urban state highway	283	20.9%	290	21.4%
Rural city street	53	3.9%	53	3.9%
Rural county trunk	55	4.1%	49	3.6%
Rural interstate highway	16	1.2%	12	0.9%
Rural state highway	167	12.3%	114	8.4%
Rural town road	49	3.6%	56	4.1%
Total	1356	100.0%	1358	100.0%

More than half of bicyclist FSI crashes were also on urban city streets, and the second most common roadway type was urban state highway. Bicyclist FSI crashes decreased between 2008-2012 and 2018-2022 on nearly all roadway types. However, bicyclist FSI crashes became more common on rural county trunk highways, with this roadway type increasing from 5% to 9% of bicyclist FSI crashes between 2008-2012 and 2018-2022.

Table 22. Bicyclist FSI Crashes by Roadway Type, 2008-2012 vs. 2018-2022

	2008-2012		2018-2022	
	Number	%	Number	%
Urban city street	335	56.6%	257	59.8%
Urban county trunk	0	0.0%	2	0.5%
Urban interstate highway	0	0.0%	2	0.5%
Urban state highway	105	17.7%	73	17.0%
Rural city street	34	5.7%	16	3.7%
Rural county trunk	31	5.2%	40	9.3%
Rural interstate highway	0	0.0%	1	0.2%
Rural state highway	44	7.4%	19	4.4%
Rural town road	43	7.3%	20	4.7%
Total	592	100.0%	430	100.0%

3.4.6. Pedestrian FSI and Bicyclist FSI Crashes and Bus Stop Proximity

Our final geographic analyses determined how many geocoded pedestrian FSI and bicyclist FSI crashes occurred near bus stops (locations as of 2018). Approximately half of statewide pedestrian FSI crashes were within 0.1 miles of a bus stop, and about 30% were within 50 meters of a bus stop (Table 23). This likely reflects the high proportion of crashes in pedestrian-oriented urban areas served by public transit, but it may also indicate high pedestrian exposure and risk near specific bus stop locations.

Bicyclist FSI crashes were also common near bus stops, but smaller proportions were within 0.1 miles of a bus stop and within 50 meters of a bus stop than pedestrian FSI crashes (Table 24). Notably, the proportions of bicyclist crashes close to transit decreased between 2008-2012 and 2018-2022.

Table 23. Geocoded Pedestrian FSI Crashes by Proximity to Bus Stops, 2008-2012 vs. 2018-2022

	2008-2012		2018-2022	
	Number	%	Number	%
All geocoded locations	1291	100.0%	1556	100.0%
Within 1/10 mile	641	49.7%	805	51.7%
Within 50 m	393	30.4%	437	28.1%

Table 24. Geocoded Bicyclist FSI Crashes by Proximity to Bus Stops, 2008-2012 vs. 2018-2022

	2008-2012		2018-2022	
	Number	%	Number	%
All geocoded locations	560	100.0%	432	100.0%
Within 1/10 mile	268	47.9%	184	42.6%
Within 50 m	154	27.5%	94	21.8%

3.5. Temporal Shifts in Pedestrian and Bicyclist Injuries

First, we examined statewide pedestrian FSI and bicyclist FSI crashes between 2008 and 2024 by month of the year. Pedestrian FSI crashes do not have a strong seasonal pattern, but they tend to peak in September through November, with the highest proportion of crashes often occurring in October (Table 25). This season has decreasing sunlight, the beginning of the school year, the transition from daylight saving time back to standard time, and moderate temperatures that support pedestrian activity. This seasonal trend has generally been consistent over time, with a slight increase in October and slight decreases in May and June between 2008-2012 and 2018-2022. Bicyclist FSI crashes show a strong seasonal pattern, with much higher proportions of crashes occurring during the warm summer months than the cold winter months (Table 26). Approximately half of bicyclist FSI crashes occurred during July through September, with slight increases across this three-month period between 2008-2012 and 2018-2022.

Table 25. Proportion of Pedestrian FSI Crashes by Month, 2008-2024

	Total Crashes	Proportion of FSI Crashes											
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2008	363	7.2%	6.9%	5.5%	6.3%	9.9%	8.8%	11.0%	9.9%	8.5%	10.2%	9.4%	6.3%
2009	315	6.0%	6.0%	6.7%	7.3%	7.6%	9.5%	8.6%	5.7%	12.7%	9.2%	9.5%	11.1%
2010	324	7.4%	6.2%	6.2%	9.0%	9.9%	7.7%	8.3%	5.6%	7.4%	10.5%	13.0%	9.0%
2011	320	8.4%	8.1%	9.7%	7.2%	8.4%	5.3%	6.9%	10.6%	7.5%	9.4%	8.1%	10.3%
2012	310	6.5%	5.8%	6.1%	5.5%	10.3%	9.4%	8.7%	7.4%	11.0%	10.0%	10.0%	9.4%
2013	296	7.4%	4.4%	6.4%	8.8%	10.8%	8.1%	9.8%	9.8%	5.7%	10.8%	8.8%	9.1%
2014	269	8.2%	8.2%	4.5%	5.6%	6.7%	6.3%	7.8%	8.2%	10.8%	12.3%	8.6%	13.0%
2015	310	7.4%	4.5%	6.8%	8.4%	6.5%	7.1%	11.3%	8.7%	9.7%	10.3%	12.3%	7.1%
2016	300	5.3%	7.7%	6.7%	7.0%	8.0%	8.0%	11.0%	6.7%	7.3%	9.7%	14.0%	8.7%
2017	333	6.9%	6.9%	6.9%	7.2%	9.3%	8.4%	11.1%	6.0%	9.0%	9.0%	10.2%	9.0%
2018	321	6.9%	8.4%	5.0%	9.0%	8.7%	4.7%	10.9%	6.9%	7.8%	10.9%	11.5%	9.3%
2019	327	8.6%	3.4%	5.8%	5.2%	6.1%	5.8%	9.2%	11.0%	11.6%	12.8%	11.6%	8.9%
2020	296	4.7%	7.1%	5.1%	4.7%	5.4%	8.1%	9.8%	10.5%	10.8%	12.8%	10.5%	10.5%
2021	315	6.7%	6.0%	7.6%	7.3%	9.2%	8.3%	6.0%	8.3%	10.2%	14.0%	7.0%	9.5%
2022	329	9.4%	5.2%	6.7%	5.5%	7.9%	7.9%	8.5%	10.6%	9.4%	11.6%	8.2%	9.1%
2023	310	7.1%	5.8%	6.8%	8.4%	10.3%	8.4%	8.4%	7.4%	8.7%	10.3%	7.1%	11.3%
2024	307	4.2%	7.2%	6.2%	8.1%	6.5%	7.5%	7.8%	10.1%	11.1%	10.7%	9.4%	11.1%
Total	5345	7.0%	6.3%	6.4%	7.1%	8.4%	7.6%	9.1%	8.4%	9.4%	10.8%	10.0%	9.5%
2008-2012	1632	7.1%	6.6%	6.8%	7.0%	9.3%	8.1%	8.8%	7.9%	9.4%	9.9%	10.0%	9.1%
2018-2022	1588	7.3%	6.0%	6.0%	6.4%	7.5%	6.9%	8.9%	9.4%	9.9%	12.4%	9.8%	9.4%

Table 26. Proportion of Bicyclist FSI Crashes by Month, 2008-2024

	Total Crashes	Proportion of FSI Crashes											
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2008	129	1.6%	1.6%	3.1%	10.9%	10.1%	15.5%	18.6%	14.7%	13.2%	7.8%	3.1%	0.0%
2009	125	0.0%	2.4%	2.4%	4.0%	13.6%	17.6%	19.2%	16.8%	12.0%	9.6%	2.4%	0.0%
2010	118	0.0%	0.8%	2.5%	7.6%	11.9%	15.3%	17.8%	14.4%	11.9%	12.7%	4.2%	0.8%
2011	118	1.7%	0.8%	0.8%	4.2%	10.2%	8.5%	11.9%	26.3%	12.7%	13.6%	5.9%	3.4%
2012	126	3.2%	1.6%	4.8%	5.6%	7.1%	12.7%	17.5%	16.7%	17.5%	9.5%	2.4%	1.6%
2013	97	1.0%	1.0%	2.1%	3.1%	12.4%	17.5%	15.5%	16.5%	12.4%	10.3%	4.1%	4.1%
2014	99	0.0%	0.0%	1.0%	4.0%	10.1%	18.2%	20.2%	18.2%	12.1%	9.1%	5.1%	2.0%
2015	88	0.0%	1.1%	2.3%	6.8%	8.0%	18.2%	13.6%	20.5%	14.8%	8.0%	4.5%	2.3%
2016	119	0.8%	1.7%	7.6%	6.7%	5.9%	15.1%	14.3%	18.5%	17.6%	6.7%	5.0%	0.0%
2017	85	0.0%	2.4%	2.4%	5.9%	10.6%	17.6%	16.5%	7.1%	20.0%	11.8%	4.7%	1.2%
2018	79	1.3%	0.0%	6.3%	1.3%	16.5%	15.2%	20.3%	15.2%	16.5%	5.1%	1.3%	1.3%
2019	95	1.1%	1.1%	0.0%	4.2%	6.3%	11.6%	28.4%	14.7%	18.9%	4.2%	5.3%	4.2%
2020	87	2.3%	0.0%	0.0%	2.3%	10.3%	12.6%	21.8%	20.7%	14.9%	5.7%	6.9%	2.3%
2021	96	1.0%	2.1%	4.2%	9.4%	10.4%	14.6%	13.5%	13.5%	16.7%	9.4%	3.1%	2.1%
2022	84	0.0%	1.2%	2.4%	3.6%	9.5%	9.5%	14.3%	20.2%	17.9%	11.9%	6.0%	3.6%
2023	99	1.0%	3.0%	0.0%	5.1%	3.0%	14.1%	15.2%	23.2%	11.1%	10.1%	5.1%	9.1%
2024	114	0.9%	1.8%	2.6%	0.9%	3.5%	19.3%	10.5%	18.4%	18.4%	16.7%	4.4%	2.6%
Total	1758	1.0%	1.4%	2.7%	5.2%	9.3%	14.9%	16.9%	17.5%	15.1%	9.7%	4.3%	2.3%
2008-2012	616	1.3%	1.5%	2.8%	6.5%	10.6%	14.0%	17.0%	17.7%	13.5%	10.6%	3.6%	1.1%
2018-2022	441	1.1%	0.9%	2.5%	4.3%	10.4%	12.7%	19.7%	16.8%	17.0%	7.3%	4.5%	2.7%

Second, we analyzed pedestrian FSI and bicyclist FSI crashes by hour of the week. Considering statewide pedestrian FSI crashes during 2008-2012 (Table 27) and 2018-2022 (Table 28), the highest proportions of these crashes occurred in the late afternoon (3-5 pm) and early evening (6-8 pm) periods on weekdays and on Friday and Saturday nights (9-11 pm and going into 12-2 am on the following mornings). Comparing 2008-2012 with 2018-2022 showed increasing proportions of pedestrian FSI crashes during certain evening and night periods, particularly early evenings (6-8 pm), early night (9-11 pm), and very early mornings (3-5 am). A smaller proportion of pedestrian FSI crashes occurred during the daytime (6 am-5 pm) and late night (12-2 am) during 2018-2022. These shifts appeared to be more prominent between hours of the day than different days of the week.

Table 27. Percentage of Pedestrian FSI Crashes by Weekday Period, 2008-2012

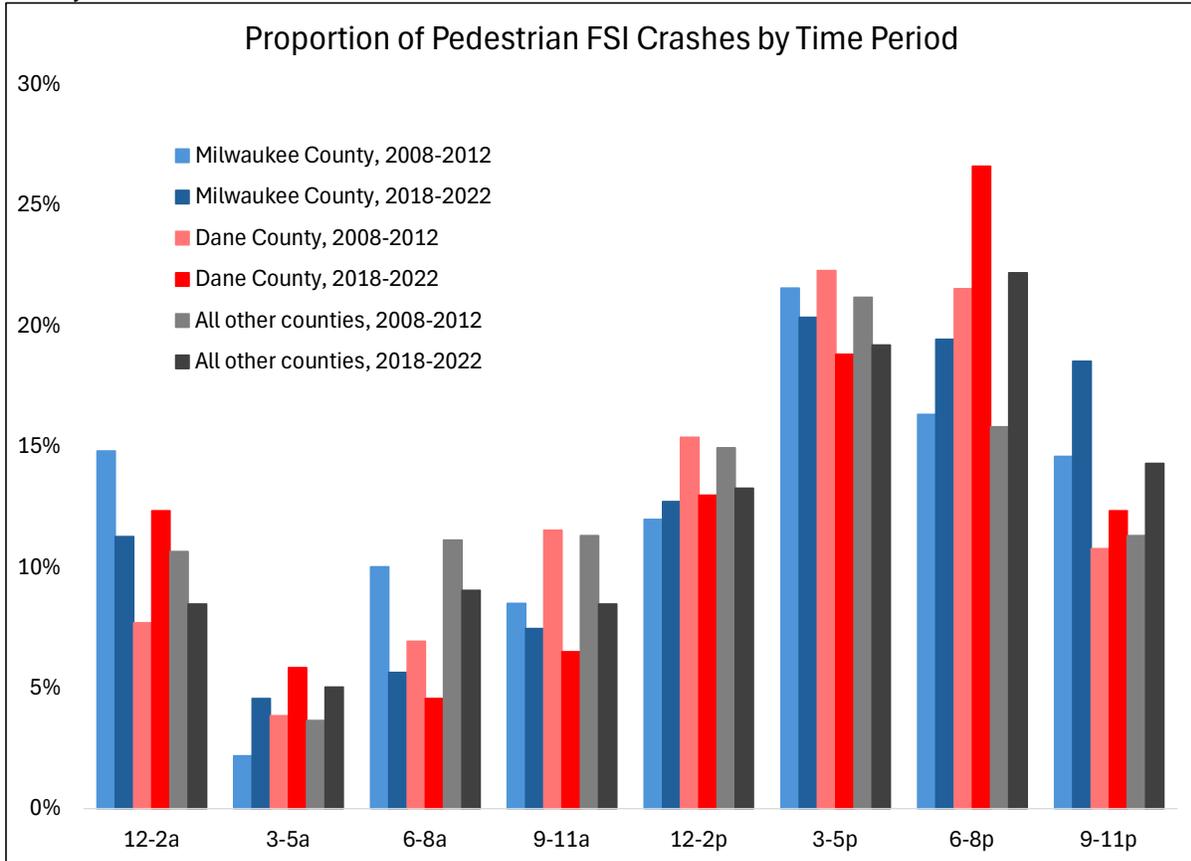
Percentage of Pedestrian FSI Crashes by Weekday Period, 2008-2012										
	Total Crashes	Total	12-2a	3-5a	6-8a	9-11a	12-2p	3-5p	6-8p	9-11p
Monday	199	12.2%	0.6%	0.2%	2.3%	1.7%	2.0%	2.9%	1.6%	0.9%
Tuesday	185	11.3%	0.6%	0.3%	1.2%	1.0%	1.7%	3.4%	2.0%	1.2%
Wednesday	263	16.1%	0.7%	0.5%	2.3%	1.8%	2.5%	4.2%	2.8%	1.3%
Thursday	242	14.8%	1.0%	0.4%	2.4%	1.5%	1.7%	3.6%	2.6%	1.7%
Friday	266	16.3%	0.9%	0.4%	1.4%	1.6%	3.1%	3.7%	2.8%	2.4%
Saturday	249	15.3%	3.8%	0.6%	0.5%	1.7%	1.6%	2.1%	1.9%	3.1%
Sunday	228	14.0%	3.9%	0.8%	0.4%	1.3%	1.7%	1.6%	2.7%	1.7%
Total	1632	100.0%	11.6%	3.2%	10.5%	10.5%	14.2%	21.4%	16.4%	12.2%

Table 28. Percentage of Pedestrian FSI Crashes by Weekday Period, 2018-2022

Percentage of Pedestrian FSI Crashes by Weekday Period, 2018-2022										
	Total Crashes	Total	12-2a	3-5a	6-8a	9-11a	12-2p	3-5p	6-8p	9-11p
Monday	216	13.7%	0.8%	0.8%	1.5%	1.3%	2.1%	3.2%	3.0%	1.1%
Tuesday	201	12.7%	0.6%	0.5%	1.3%	0.9%	1.7%	3.4%	2.8%	1.5%
Wednesday	210	13.3%	0.5%	0.6%	1.1%	1.3%	2.2%	2.7%	3.0%	1.8%
Thursday	223	14.1%	0.7%	0.4%	1.1%	0.9%	2.0%	3.3%	3.4%	2.3%
Friday	239	15.1%	0.6%	0.5%	1.2%	1.5%	2.1%	3.4%	3.0%	2.9%
Saturday	270	17.1%	2.8%	0.8%	0.7%	1.5%	1.9%	2.2%	3.2%	4.1%
Sunday	219	13.9%	3.8%	1.5%	0.4%	0.6%	1.1%	1.5%	3.2%	1.8%
Total	1578	100.0%	9.8%	4.9%	7.4%	7.9%	13.1%	19.6%	21.7%	15.6%

Recognizing the prominent shift in pedestrian FSI crashes toward evening, early night, and very early morning, we examined these patterns in Milwaukee County, Dane County, and all other counties to see if this temporal pattern varied geographically (Figure 22). This showed that the temporal shift in pedestrian FSI crashes between 2008-2012 and 2018-2022 occurred broadly, with similar patterns in each study area. These areas all experienced increases during these specific nighttime periods despite having different overall pedestrian FSI crash trends (a 20% increase from 459 to 550 in Milwaukee County, an 18% increase from 130 to 154 in Dane County, and a 16% decrease from 1,043 to 874 in all other counties).

Figure 22. Proportion of Statewide Pedestrian FSI Crashes by Time Period: Milwaukee County, Dane County, and all other counties, 2008-2012 vs. 2018-2022



Examining bicyclist FSI crashes during 2008-2012 (Table 29) and 2018-2022 (Table 30), these types of crashes were more likely to occur on weekdays than on Saturday and Sunday. Higher proportions of bicyclist FSI crashes tended to happen during the afternoon and early evening (12-8 pm) on weekdays. There did not appear to be notable shifts in this temporal pattern between 2008-2012 and 2018-2022.

Table 29. Percentage of Bicyclist FSI Crashes by Weekday Period, 2008-2012

	Total Crashes	Percentage of Bicyclist FSI Crashes by Weekday Period, 2008-2012								
		Total	12-2a	3-5a	6-8a	9-11a	12-2p	3-5p	6-8p	9-11p
Monday	100	16.2%	0.2%	0.0%	2.4%	2.3%	3.4%	4.9%	2.4%	0.6%
Tuesday	98	15.9%	0.0%	0.3%	2.1%	1.6%	2.8%	5.4%	2.8%	1.0%
Wednesday	98	15.9%	0.2%	0.2%	2.3%	1.9%	2.1%	5.7%	3.4%	0.2%
Thursday	82	13.3%	0.2%	0.0%	0.6%	1.9%	2.9%	4.2%	2.8%	0.6%
Friday	110	17.9%	0.3%	0.0%	1.8%	1.9%	3.9%	4.4%	4.1%	1.5%
Saturday	76	12.3%	1.3%	0.2%	1.1%	2.3%	1.9%	2.9%	1.1%	1.5%
Sunday	52	8.4%	0.6%	0.0%	0.3%	1.5%	2.6%	1.9%	1.1%	0.3%
Total	616	100.0%	2.8%	0.6%	10.7%	13.5%	19.6%	29.4%	17.7%	5.7%

Table 30. Percentage of Bicyclist FSI Crashes by Weekday Period, 2018-2022

		Percentage of Bicyclist FSI Crashes by Weekday Period, 2018-2022								
	Total Crashes	Total	12-2a	3-5a	6-8a	9-11a	12-2p	3-5p	6-8p	9-11p
Monday	60	13.6%	0.2%	0.0%	0.9%	2.0%	3.0%	3.4%	2.3%	1.8%
Tuesday	72	16.4%	0.2%	0.2%	2.5%	1.1%	1.8%	6.1%	3.4%	0.9%
Wednesday	67	15.2%	0.0%	0.5%	0.9%	2.5%	3.0%	5.0%	2.5%	0.9%
Thursday	77	17.5%	0.2%	0.2%	3.2%	2.3%	2.3%	4.3%	4.3%	0.7%
Friday	59	13.4%	0.5%	0.0%	1.1%	2.0%	2.3%	4.1%	2.7%	0.7%
Saturday	56	12.7%	1.4%	0.0%	0.9%	1.6%	2.0%	3.6%	2.3%	0.9%
Sunday	49	11.1%	0.2%	0.0%	0.9%	2.0%	2.3%	3.4%	2.0%	0.2%
Total	440	100.0%	2.7%	0.9%	10.5%	13.6%	16.6%	30.0%	19.5%	6.1%

3.6. Practitioner Interview Themes

We conducted interviews with local practitioners from six agencies in different parts of Wisconsin to identify transportation infrastructure, policy, or land development changes that might be associated with geographic or temporal shifts in pedestrian and bicyclist injuries between 2008-2012 and 2018-2022. We asked these staff to comment specifically on any apparent shifts that they had observed from crash data or through anecdotal experience. Key themes from these interviews are presented below.

The first three themes are possible reasons for increases in pedestrian and bicyclist injuries over time. The remaining themes describe ways that communities were reducing pedestrian and bicyclist risk.

3.6.1. Possible Reasons for Increased Pedestrian and Bicyclist Injuries

Practitioners suggested a variety of reasons why pedestrian and bicyclist injury risk may have increased in their communities during the 2010s, but three themes were mentioned across multiple interviews: dispersed development, driver behavior, and pedestrian activity at night.

Dispersed Development

Several interviewees mentioned development on the edge of urban areas being served by roadways with high speeds and inadequate pedestrian and bicycle facilities. In some cases, these roadways were designed and built before development occurred. Some interviewees shared concerns about crash risk for people without cars who depend on walking and bicycling, especially in newly developed areas that public transit service does not reach.

- “Land use trends have probably created more risk for bicyclists and pedestrians. We have more housing in areas that weren’t particularly designed for people walking and biking—your traditional suburban mall-type development.”
- “De-densifying the city leads to a decrease in local needs and amenities, leads to further trips,

more driving, and likely higher crash rates...It also leads to less traffic on the streets, higher speeds.”

- “I’m aware of [the suburbanization of some city jobs] from a discussion with [City X’s transit system] a while back in order to best benefit those who need the bus most.”
- “Our newest commercial area is about a mile away from my house. There are some sidewalks by my house, but then there is a gap right by the freeway interchange, and then all the development is on the other side of the freeway. They have sidewalks and bike lanes within the new development, but there is a gap between where most of the residential is, and most of the new retail where people are going. So I see it all the time where people are trying to ride across the highway, there’s no accommodations.”
- “As far as the decline in [pedestrian and bicycle] commuting, I think I would have to chalk that up to a change in the location of job centers. In that time there was a more specific move away from downtown, and more to outlying areas...neighboring communities. Those areas being more suburban, with even less infrastructure, probably makes those commutes harder.”
- “We’re continuing to see development sprawling out. We are continuing to invest in our downtown and our urban core areas. There is still interest by our communities in gaining property tax dollars to continue with residential development. I do think that helps to say ‘let’s continue to build some of this active infrastructure’.”
- “The continued gutting of neighborhood schools and the lack of students walking and biking to school, which in turn leads to more kids getting driven to school by their parents, leads to just more traffic during busy times of the day.”
- “If [pedestrians] don’t have a transit option, and a lot don’t have a motor vehicle as well, either they have to get a ride, or ride their bike or walk to these communities that don’t have transit, which means there’s more people on these busy roadways than if would be able to ride transit.”
- “In some of the closer neighborhoods, there have probably been substantial increases in household income, and in some areas, that has probably pushed our lower-income residents farther out in the city. Much of [our pedestrian fatality data] is farther out, not downtown.”

In addition to physical infrastructure and connectivity challenges in these urban fringe areas, two regional agency interviewees mentioned that residents in these areas may be more likely to resist proposed pedestrian and bicycle fatalities than people living in older, more central neighborhoods.

Driver Behavior

Many interviewees implied that pedestrian and bicyclist safety was impacted by worsening driver

behavior, and several highlighted specific aspects of driver behavior that were becoming more problematic.

- “The perception [is] that reckless driving has dramatically increased over time.”
- “I think [speeding behavior] has remained pretty steady since 2020. I can say on the drinking and driving, we have seen a slight decrease. In the ten years prior, 50% of total fatalities involved impaired driving. We’re down to 43%.” “Still above the state average.”
- Factors leading to higher pedestrian and bicyclist injury rates: “Lessening congestion could have led to higher speeds over time, and the wide adoption of cellphone usage, so distracted driving.”

In contrast to driver behavior, pedestrian and bicyclist behavior was rarely mentioned by interviewees as a contributing factor to changes in pedestrian or bicyclist crashes during the 2010s.

Several interviewees mentioned that law enforcement practices may impact driver behavior.

- “The change in the police pursuit policy [so that police could not pursue drivers who fled from traffic stops] happened in the mid-2010s. People could drive with reckless abandon without fear of-getting pulled over.”
- “[City X] police department is a good partner; they have a traffic safety enforcement team. They have quite limited resources, and we can’t conduct as much enforcement as we would like to, but they do regularly carry out safety efforts focused on speeding. They will have a police officer acting as a pedestrian stepping out into the street, seeing how traffic behaves, and pulling over people. Our parking enforcement team does a lot of work around schools, doing education, handing out flyers.”

Pedestrian Activity at Night

Nighttime pedestrian safety was mentioned by several interviewees. Nighttime has a higher injury risk for pedestrians than daytime because they are harder for drivers to see and alcohol use is more common by both pedestrians and bicyclists.

- “Probably for [the increase in fatalities for] pedestrians, you’re dealing with crossing streets mostly at night. You could have a pedestrian who is impaired, you could have a driver that’s impaired, but then throw in the combination of not being able to see them.”
- “A lot of the pedestrian crashes I’ve seen [have been] in the rural areas, people walking along the roadways. And it has been at night, under the cover of darkness. So I’m guessing the combination of the visibility of the walkers, they may be wearing darker colors... or it could be the driver is impaired. It’s more common during the night that that type of driving would occur.”

While interviewees mentioned high crash risk for pedestrians at night, they did not state directly that more pedestrians were out at night or that the risk at night was getting worse. Therefore, darkness continues to be important to mitigate, but practitioners do not seem to perceive that this risk factor is shifting over time.

3.6.2. Strategies Intended to Lower Pedestrian and Bicyclist Injury Risk

Interviewees focused a majority of their answers on strategies that they have implemented to decrease pedestrian and bicyclist crash risk. These positive strategies included many interrelated actions: establish plans and policies, redesign roadways, receive support from local advocates, receive support from elected officials, increase resources for pedestrian and bicyclist safety projects, collaborate with WisDOT, and institutionalize pedestrian and bicyclist safety practices.

Establish Plans and Policies

Communities have adopted plans and policies to build public support for implementation of pedestrian and bicycle safety improvements and to increase opportunities for grant funding.

- “[City X] adopted a complete streets ordinance... We also have bike parking requirements. When [City Y] do their site plan application reviews, they have a checklist of connectivity to existing bike paths and sidewalks. There are a lot of improvements still to be made, especially in rural areas.”
- “It was really with the adoption of Vision Zero five-ish years ago, that the public-facing promotion of safety, staff and city officials really came to the fore much moreso.”
- “The bike ped plans that the MPO has produced have been pretty universally adopted by local communities.”
- “In 2008-2009, we have now a safe routes to school coordinator, and three staff. In 2014, we updated our bicycle and pedestrian plan, and has since been a full time bicycle and pedestrian coordinator. So now we have our MPO areas, our rural program, and our safe routes to school program.”
- “A few of our communities [have adopted complete streets policies].” [City X’s] policy has probably been the most successful. Probably the largest barriers come down to funding and politics.”
- “A lot of our major roads can be funded by federal dollars, so the requirement [is] for bike ped accommodations on there.”
- “We regularly receive funding through [the federal] transportation enhancements program. We

currently have a couple safe streets for all grants, one for planning, one for implementation.”

Some interviewees believed that their communities experienced higher pedestrian and bicyclist injury rates because they did not establish plans or policies for pedestrian and bicyclist safety soon enough.

- “The transportation policy and design was in its golden era in the first half of 2010s, and [our City X] kind of missed that boat. We missed the entire decade in terms of more progressive design.”

Redesign Roadways

Most interviewees mentioned roadway design changes to improve conditions for pedestrians, bicyclists, and transit users. In general, communities made progress adding more pedestrian and bicycle infrastructure during the 2010s.

- “Safety is obviously one of our primary interests with new construction. Remove places where there were not sidewalk, widening sidewalks, making them more comfortable, safe for pedestrians. With bikes, we’ve made a dramatic push lately to make sure there are bike lanes with some level of protection.”
- “[City X] has typically been the leader in the region. They’re doing raised crosswalks, a lot of traffic calming, they have a proactive bicycle and pedestrian plan.”
- “In that time period [2012-22] is really when a lot of our planning and infrastructure elements really came into fruition.”
- City X has made progress on pedestrian and bicyclist safety because of many physical design changes to streets. “We have a whole budget for the Safe Streets program, where projects are solely scored based on their safety. We’re not just picking streets that are in poor condition. Not only do we rate our normal street projects based on things other than pavement rating, we also have a whole budget program just for safe streets. On top of that, [the traffic engineering department] has done a ton with being a vision zero member.”
- “Ever since I’ve been here, we’ve had such a high focus on bike and ped infrastructure... We’re certainly more adventurous in some of the designs... we’ve spent a lot more time on unique designs. We’re not as hampered as other agencies, as far as level of service. We try not to harm vehicle [travel] times, but it’s not going to stop us from doing a separated ped or bike facility. Our Council’s been pretty good about approving.”
- “We have a lot more [pedestrian and bicyclist safety projects] occurring in our region than 15 years ago... There was a different mindset of “bigger is always better...” turn lanes all over, that’s the safest option. There is a lot more research documentation available now that we can look at

and provide local communities when we're proposing a change."

- "One hurdle we did get rid of is assessments for sidewalks; we used to assess the property owners for a portion of the construction [of their sidewalk]. Now any sidewalk that gets built is free of charge to them. That's helped with individual project approvals."
- "Increase in bike lanes in 2010s... There's momentum to have more protected bike lanes now, especially with our...corridor studies. And that's something that we've been involved in heavily to advocate for safe alternative transportation...And then over the next 10 years we'll see an increase [in pedestrian and bicyclist safety]."
- "We've dedicated a lot of more of our improvement projects for addressing pedestrian and bicycle accommodation issues along our state highways and established more and improved accommodations in the last 15 years, is probably the biggest thing we've done."
- "We've had road diets in a lot of our more 'urban' areas, 10,000 [population] or more. We did [a community of less than 2,000]. Some communities have done it on their own...on their local principal arterial roads."
- "We added RRFBs [rectangular rapid flashing beacons] there as well. Redoing streets downtown, reintroducing new streets to mall site, introducing a new, curbsless design. It's not always taken into consideration as early or thoroughly as it should be, but I think we're making progress."
- "In 2018, we adopted a plan to provide trails to our business campus, which was kind of a dangerous area. We started to use more RRFBs for crossings...When we've reconstructed streets, we have been looking at bicycle and pedestrian accommodations, and especially ADA accommodations."
- "Our region is a little more rural...our improvements are going to be a bit different. The vast majority of our improvements have been increase in paved shoulder width along our state highways, we heavily have tried to mark on-street accommodations throughout our urban areas, at least urban shoulders (about the same width as a bike lane without the markings). It provides a visual narrowing of the roadway and a space for the cyclist to ride."

However, several interviewees noted that there are still many challenges to developing complete, connected, and low-stress networks of pedestrian and bicycle facilities. These include a lack of physical protection from vehicles, maintenance challenges, and previously constructed roadways that did not include active transportation facilities.

- "...we have seen an increase in bike lanes. They are not separated bike lanes, there have been some safety issues with that as well."
- "On the west side, [Highway X] was rebuilt. That acts as much like a river as much as an actual

river. Having proper bike/ ped accommodations when those were built was not exactly properly considered.”

- “Usually once [infrastructure] is in, the reception is pretty good after that.”
- “There’s pros and cons to moving quickly. One of the cons is maintenance is often overlooked: we have far too many delineators and signs because of our snow-ops teams wanting to know where everything is on the streets. That leads to really ugly-looking designs, and more stuff on the street that can be damaged and needs repair. We’ve done a good job building staff for design, but we have not done the same for maintenance and upkeep.”

Relatively few interviewees mentioned setting lower speed limits as a pedestrian and bicyclist safety strategy. Exceptions came from one community, though the speed limit changes were mostly after 2020:

- “In the past few years since we have joined vision zero... we’ve made substantial speed limit reductions across our arterial and major collector network, often bring speeds down as low as 25. We reduced the speed on all local streets to 20 mph. It required that we sign all local streets at 20mph [per state law]. We did that after running trials... and seeing a reduction in overall crashes. We’ve seen average speeds come down a couple of miles an hour, but substantial reductions on the major outliers... very high speeds that were previously observed.”
- City X has been “reducing speed limits on our streets. There’s been a really big effort towards these kinds of things.”
- When we are working on a reconstruction of a major arterial, we have implemented the lower speed limit with the project.”
- “The community is generally supportive or indifferent to many of the changes we make, but with every project we do hear substantial pushback of ‘what difference is this really going to make?’ I think the response to that is highlighting the data that we do have. Trying to get people to envision what the street could look like is challenging... and how slowing it to even 30 mph will not make a substantial difference in their travel time.”

Receive Support from Local Advocates

Most interviewees highlighted the value of pedestrian and bicyclist safety advocacy efforts from local community members. Their support made certain projects possible that may have faced political or budget challenges.

- “We have a strong and long standing advocacy primarily focused bicycling. During the time frame you talked about, [Local Advocacy Group X] was formed to take on the mantle from some older advocates. It has focused on building separated or protected [bicycle] facilities, taking a

look at street projects we are proposing and saying, “this isn’t good enough.” Sometimes they’re right, and sometimes we are very constrained with the scope and scale of the project, the funding available, or other needs we need to balance.”

- “[Community X] has an active bicycling community that wants to see better infrastructure. There isn’t necessarily one advocacy group, but when there are meetings to develop the infrastructure, you will see the supporters there.”
- “[Local Advocacy Group X] take a little bit of a look at pedestrian safety, but not a whole lot. I do wish we had more people in town who thought of themselves as pedestrians. Nobody really thinks of themselves as pedestrian, though we all are. It’d be great when we are looking to expand the sidewalk network, if we had more people pushing from the other side, as we do on the bike side of things.”
- “One sort of big win in the last year: there was a bike/ped bridge that was a WisDOT project that had been planned for 7-10 years. People thought it was a waste of money but we see people on it all the time, and saying how nice it is. From an advocacy [standpoint], we’ve been trying to celebrate these wins, we did a little press conference, to advertise.”

Still, engaging with local advocates can be challenging for completing projects efficiently.

- “It has been challenging to help some of our advocates understand the constraints or scope of a project. A simple resurfacing turns into long drawn-out fights of ‘well, why can’t you add this and this and this?’ and pretty soon we’re in a near reconstruction of a project. There’s often letting perfect stands in the way of good. If we can’t get the perfect facility, then why do anything at all?”

Receive Leadership from Elected Officials

Interviewees also emphasized that support from elected officials made a big difference in being able to implement pedestrian and bicyclist safety initiatives.

- “The leadership has been very consistently pro bike and pro walking.”
- “We have had a series of elected officials and a mayor who are strongly supportive of traffic safety.”
- “Staff within the department still was very much set in their ways...rebuild as is, bike/ ped is not priority.” [There has been a change the last two or so years] within the department, making safety a priority, bike/ped design a priority, and trying to build beyond the multimodal unit.”
- “Some of it really does just boil down to, ‘do you have a supportive council?’ Is this a priority for your community?”

Increase Resources for Safety Projects

Some interviewees mentioned having limited resources in their community for pedestrian and bicycle safety projects. In particular, pedestrian and bicyclist safety improvements are often reactive—relying on reported crash data and responding to problems only after crashes occur.

- “The biggest challenge is having enough funds to do everything necessary and then...to do the type of improvements that the local communities would desire. Our department has focused on smaller type projects like resurfacing, rather than reconstruction projects. Part of the reason is we want to maximize the life of these highway facilities without having an expensive reconstruction projects, but we can’t do as much on the bicycle and pedestrian accommodations inside of it.”
- “Funding... One of the biggest hurdles for bike and pedestrian issues is that HSIP [the Highway Safety Improvement Program] which is a primary safety fund, you pretty much have to have a major crash or fatality documented [to receive funds].”

In contrast, several others highlighted that they had resources from local funding initiatives and state and federal grants.

- “We also have a whole separate budget program just for safe streets...It’s always kind of been around [in our budget]...It’s between \$1-\$2 million a year for small things like: adding a hybrid beacon somewhere, or adding a raised crossing.”
- “We... regularly receive funding through the transportation enhancements program. We have a couple safe streets for all grants. There are a lot of challenges with using that [state and federal] money as well, A lot of complexity, whereas when we can do things locally, it’s often quicker and easier, and sometimes has a better outcome as well.”

Collaborate with WisDOT

Local and regional interviewees tended to have good working relationships with WisDOT staff. Further, WisDOT and federal leadership is crucial for local agencies to make progress integrating pedestrian and bicyclist safety measures into roadway projects.

- One interviewee spoke about their process of integrating pedestrian and bicycle accommodations into their new roadway projects: “We [add pedestrian and bicycle facilities as a part of roadway projects] now because Wisconsin Department of Transportation redid their facility development manual section on bike and pedestrian accommodations about 15 years ago. That was because the federal policy had changed.”
- “Working with the state is very important, and they are the ones leading the projects [for our

area]. We are seeing a higher focus on bicycle and pedestrian networks and connectivity with those projects as well. They're not focusing on lane expansion to address congestion [but rather] lane reduction, which we believe here will only benefit bicycle and pedestrian safety.

- “Within the region, with our highway improvement projects, we've have a greater focus on providing...better bike and pedestrian accommodations along our state highways. Whenever we have a project that is new, one of the items that we look at is... if the bicycle and pedestrian accommodations are adequate or not. [relative to older projects].”

Still, some interviewees mentioned local jurisdiction priorities for safety sometimes conflicted with mobility goals on state highways and that a high proportion of pedestrian crashes were on state-owned roadways.

- “2008-22, we had 10 bike fatalities. 6 of those were on streets that we don't have full or any jurisdiction over. 45 pedestrian fatalities, 25-30 of those were again streets that we are not the full owner of. That limits our ability to make some of the changes and improvements. For us, safety is at or near the top of that list. Some of our partners on the roadway network, have mandates or other priorities. Although safety is always a high consideration for them, they may have throughputs considerations, level of services, widths of travel lanes, a whole variety of things.”

Institutionalize Pedestrian and Bicyclist Safety Practices

Agencies that have been promoting pedestrian and bicycle activity and safety for more years may have experienced better pedestrian and bicyclist safety outcomes during the 2010s. This may be due in part to having the responsibility for providing high-quality pedestrian and bicycle accommodations integrated across many staff members rather than being the sole responsibility of one pedestrian and bicycle coordinator or unit.

- “Staffing within our traffic engineering departments has grown. We don't have a separate multimodal design unit. It's really integrated throughout our traffic engineering departments. Our number of staff involved with bike and ped safety has probably grown, but there has not been growth of those with 'bicycle' or 'pedestrian' in their title.”

4. ONLINE RESULTS

This report includes static maps and charts to show geographic and temporal shifts in Wisconsin pedestrian and bicyclist injuries. To make these results more dynamic and accessible to the public, we created an ArcGIS StoryMap with interactive maps and charts to illustrate these changes over time. Since additional crash data were available at the end of our project, we include trends from 2008 through 2024 in our StoryMap.

The online StoryMap is available here:

<https://storymaps.arcgis.com/stories/e98430b148e44665ac1004158b37f1cd>

This resource will help practitioners understand our research results more clearly. As an online resource, it will also help increase awareness of pedestrian safety trends and needs among the general public.

5. IMPLICATIONS FOR PRACTICE

The results from this research project suggest several project delivery strategies and internal organization strategies that WisDOT could consider to create a safer statewide transportation system for pedestrians and bicyclists. In practice, these strategies will be balanced with other considerations, but they indicate important directions for WisDOT to explore.

5.1. WisDOT Project Delivery Strategies

Project delivery strategies include actions that WisDOT could take as a part of its ongoing business practices. As WisDOT updates its asset performance management and budgeting methods, there may be opportunities to prioritize investments in projects that have the greatest safety benefits for pedestrians and bicyclists.

Prioritize investments in multimodal roadway reconstruction projects in developed areas. As suggested by interview participants and shown by the census tract analysis across eight states, neighborhoods with higher population densities tend to have fewer FSI pedestrian crashes. Infrastructure investments in already-developed areas rather than on the edge of new development can help support denser development patterns that reduce reliance on automobiles and support lower traffic speeds. While development patterns are determined by local communities, this study suggests that if WisDOT invests more heavily in multimodal roadway projects that serve existing and compact development, this would create a safer system for pedestrians and bicyclists. This would involve WisDOT becoming more proactively involved in land use planning discussions with local governments.

Dedicate additional resources for pedestrian and bicyclist safety within WisDOT projects on urban state highways, rural main streets, and other arterial roadways with high existing and potential pedestrian and bicyclist activity levels. High-volume arterial roadways were consistently associated with both FSI pedestrian and FSI bicyclist crashes in the census tract crash models. In urban areas, arterial roadways also often have bus stops, another common feature associated with pedestrian FSI crashes. Interview participants identified the importance of physical design changes—reducing lanes and slowing speeds—on these types of roadways as an effective strategy to improve pedestrian and bicyclist safety. Arterial roadway projects should prioritize safety and multimodal access over automobile speed, especially in areas with high levels of existing and potential pedestrian and bicyclist activity.

Dedicate additional resources for pedestrian safety improvements within the WisDOT Southeast Region and other large cities. Our analyses at the region and city level showed that pedestrian crashes have shifted to become more severe since 2008 in the Southeast Region and in many large cities across Wisconsin. Many factors could be involved in this change, but the data emphasizes that pedestrian safety efforts should continue to focus on reducing crashes that result in fatalities or severe injuries, especially in urban areas.

Dedicate additional resources to improve pedestrian safety at night on WisDOT and local roadways. Despite increasing numbers of pedestrian FSI crashes during darkness, most of our interview participants did not seem to be aware of increases in these crashes in the late evening and early morning hours in their communities. Nighttime and dark conditions should receive renewed attention for pedestrian safety evaluation and improvement. This could include conducting roadway lighting inventories along state and local roadways, investing in better roadway lighting, redesigning roadways for lower speeds (this makes it easier for drivers to detect pedestrians at night and also improves safety for all road users), educating drivers and pedestrians about increased risk in darkness (including emphasizing that driving at an appropriate speed for conditions includes driving slow enough to anticipate and yield to pedestrians crossing at night), supporting vehicle technologies for automated pedestrian detection, and considering new policies to establish lower nighttime speed limits (as allowed by the Manual on Uniform Traffic Control Devices).

5.2. WisDOT Internal Organization Strategies

Internal organization strategies include actions related to how WisDOT operates, including agency policies and how agency work responsibilities are structured. They would involve changes within the

agency that would ultimately lead to development of a safer system for pedestrians and bicyclists. All recommended strategies should be evaluated for potential cost impacts to WisDOT. Some would require legislative approval.

Continue to support policies to incorporate pedestrian and bicycle accommodations as a part of multimodal roadway projects. Federal policies (FHWA 2010; FHWA 2023) and grant programs and updates to the WisDOT Facilities Development Manual (FDM) (WisDOT 2025) have supported the development of a multimodal transportation system. Our interviews showed that these policies have been essential for local practitioners seeking safer roadway designs for pedestrians and bicyclists. WisDOT should continue to promote and implement FHWA Proven Safety Countermeasures that reduce risk for pedestrians and bicyclists (and other roadway users), such as speed safety cameras (pending legislative approval), sidewalks, bicycle lanes, median refuge islands, and roadway reconfigurations (FHWA 2025).

Ensure that all divisions within WisDOT consider pedestrian and bicyclist safety as a core part of their day-to-day work. Our interviews suggested that local agencies experiencing the most success at improving pedestrian and bicyclist safety over time have staff at all stages of policy development and project delivery who understand and accommodate pedestrian and bicyclist needs. In the past, WisDOT has relied on pedestrian and bicyclist expertise from specific teams of staff at the state and regional levels. WisDOT can improve pedestrian and bicyclist safety by having staff in all parts of the project delivery process, including policy development, safety analysis, project planning, preliminary design and engineering, construction, maintenance, and data collection view pedestrian and bicyclist safety as a core part of their day-to-day responsibilities.

Adopt a context-based approach for setting speed limits. Existing methods of speed limit setting rely on observing vehicle speeds and posting speed limits corresponding with the higher end of the speed distribution (e.g., 85th percentile speed). Since this approach often leads to raising speed limits over time and makes it very difficult to reduce posted speed limits, replace this approach with a context-based method. This strategy could build on new context classifications in the AASHTO Green Book and set posted speed limits to be appropriate for the land use adjacent to the roadway (e.g., neighborhood commercial district; rural village center). This approach, which would involve modifying speed limit sections of the Wisconsin Manual on Uniform Traffic Control Devices (WisDOT 2009), has been used in other countries and is being explored by other state DOTs (Hsu et al. 2025). It could help set more appropriate speed expectations for drivers on arterial roadways in urban areas, which are some of the highest-risk corridors for pedestrians and bicyclists.

Prioritize and communicate multimodal safety performance and person-based capacity metrics over automobile level of service. Automobile level of service (LOS) is often communicated as the primary performance metric for WisDOT roadway projects. This can lead to constructing roadways with more lanes and higher speeds, which have higher risk for pedestrians and bicyclists. WisDOT should instead emphasize how roadway projects will impact safety for all types of users, including pedestrians and bicyclists as well as person-based capacity, which accounts for how different alternatives accommodate pedestrian, bicyclist, transit, and automobile users traveling along and across roadways. Movement toward this approach should be discussed in collaboration with safety engineers in WisDOT regional offices.

Continue to make pedestrian and bicyclist safety analysis more proactive. Local interviewees noted that it was sometimes difficult to justify pedestrian or bicyclist safety improvements at high-risk locations until after crashes occurred. WisDOT should continue its progress moving toward more proactive pedestrian and bicyclist safety analysis methods, such as developing pedestrian safety performance functions within a systemic safety approach (Thomas et al. 2018). This includes potential revisions to the safety certification process in Section 11-38 of the WisDOT FDM (WisDOT 2025) and continuing work to improve pedestrian and bicyclist counts and pedestrian and bicyclist exposure estimates so that they can be used to calculate crash risk. It also includes engaging with local agencies and community members to better understand their perceptions of safety in roadway corridors that they use on a regular basis.

Expand the types of injury data used to analyze and make decisions about pedestrian and bicyclist safety. Pedestrian and bicyclist safety analyses and decisions are mainly based on police crash reports. However, many pedestrian and bicyclist injuries are not captured by this source (Stutts and Hunter, 1998; Schneider, Willman, and Hargarten 2023). Therefore, WisDOT should continue to explore other data sources to inform its safety analyses and prioritization processes.

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APPENDIX A. ADVANCED SPATIAL APPROACHES TO UNDERSTAND GEOGRAPHIC AND TEMPORAL SHIFTS IN PEDESTRIAN AND BICYCLIST CRASHES

This appendix explores geographic and temporal shifts in Wisconsin pedestrian and bicyclist crashes using two advanced spatial analysis methods: space-time cube analysis and emerging hot spot analysis. These analyses were led by Fahimeh Mohebbi with supervision from Dr. Xiao Qin.

A.1. Space-Time Cube Analysis

Space-time cube analysis can be used to visualize significant shifts in the number of crashes that are reported within specific geographic areas over time. Space-time cube analysis was applied to pedestrian and bicyclist crash data at the census tract level from 2008-2023 in ArcGIS Pro.⁷ Each year was treated as a discrete time step, so 15 intervals were considered in the analysis. The space-time cube map represents the changes over time on a two-dimensional map, with different colors indicating significant increases and decreases in combined totals of pedestrian and bicyclist crashes across the 15-year analysis period in specific census tracts.

Combined pedestrian and bicyclist crashes decreased significantly in some but increased significantly in other rural census tracts across the state, with no clear geographic pattern in these trends (Figure A.1). Increasing trends tended to be found in urbanized regions. For example, some tracts in the developing areas of Dane County and Kenosha County show significant increases in pedestrian and bicyclist crashes (Figure A.2). Several neighborhoods within the City of Milwaukee and suburban Milwaukee communities also showed significant increases, though there are exceptions where pedestrian and bicyclist crashes decreased.

⁷ Environmental Systems Research Institute, Inc. (ESRI). (2025). How Create Space Time Cube Works. Accessed July 15, 2025, <https://pro.arcgis.com/en/pro-app/latest/tool-reference/space-time-pattern-mining/learnmorecreatecube.htm>.

Figure A.1. Space-Time Cube Analysis of Pedestrian and Bicyclist Crashes by Tract, Statewide (2008-2023)

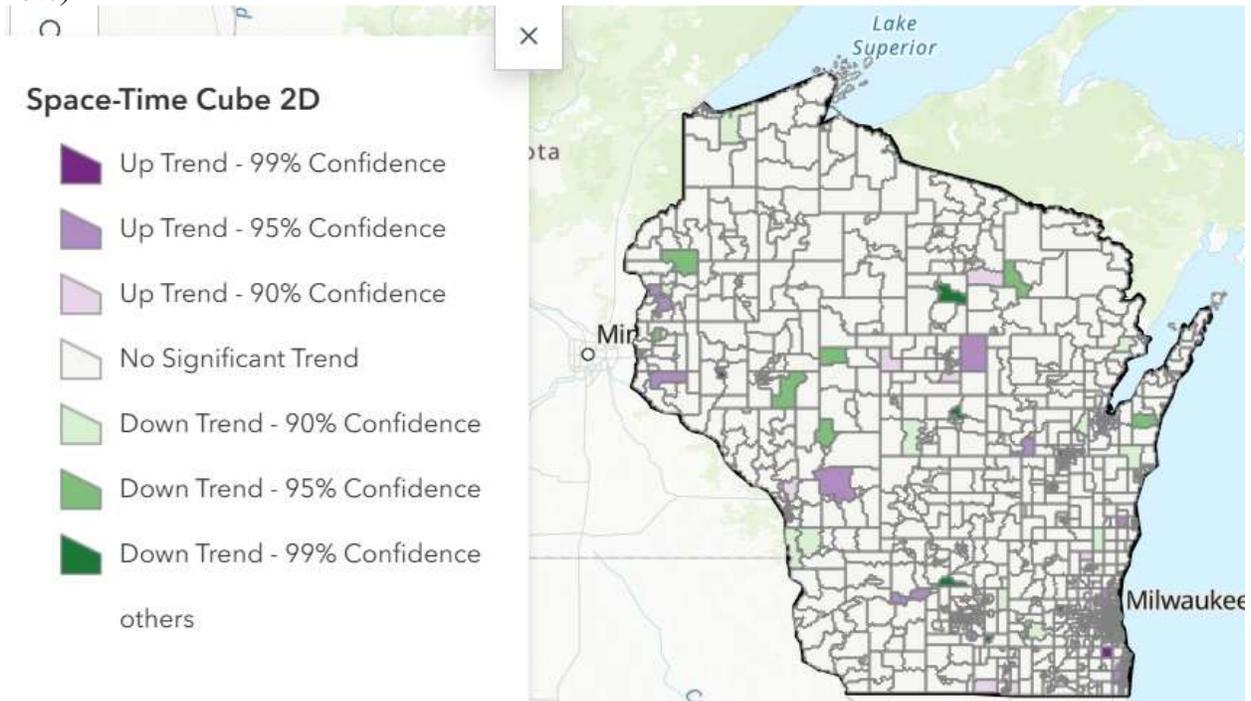
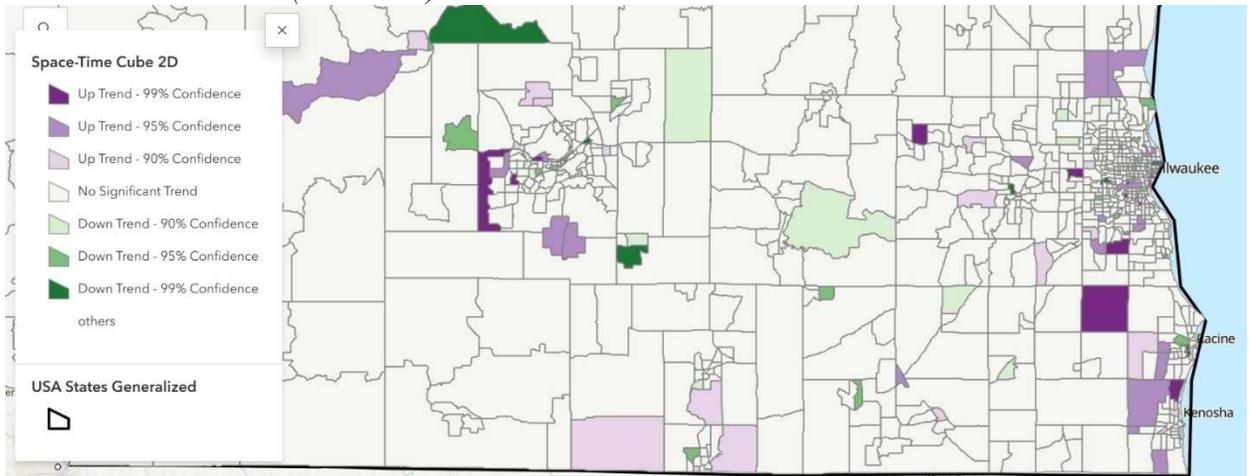


Figure A.2. Space-Time Cube Analysis of Pedestrian and Bicyclist Crashes by Tract, Southern and Southeastern Wisconsin (2008-2023)



A.2. Emerging Hot Spot Analysis

Emerging hot spot analysis is similar to space-time cube analysis because it illustrates shifts in pedestrian and bicyclist crash patterns over time. However, it accounts for similarities in crash patterns among nearby census tracts, making it possible to identify “hot spots”, or spatial clusters of census tracts with increasing or decreasing numbers of pedestrian and bicyclist crashes over time. As done previously, emerging hot spot analysis was applied to combined pedestrian and bicyclist crash data at the census tract level from 2008-2023 in ArcGIS Pro.⁸ Based on this source, our analysis identified several types of crash pattern clusters:

- ***New Hot Spot:*** A location that is a statistically significant hot spot for the final time step and has never been a statistically significant hot spot before.
- ***Consecutive Hot Spot:*** A location with a single uninterrupted run of at least two statistically significant hot spot bins in the final time-step intervals. The location has never been a statistically significant hot spot prior to the final hot spot run, and less than 90 percent of all bins are statistically significant hot spots.
- ***Intensifying Hot Spot:*** A location that has been a statistically significant hot spot for 90 percent of the time-step intervals, including the final time step. In addition, the intensity of clustering of high counts in each time step is increasing overall, and that increase is statistically significant.
- ***Persistent Hot Spot:*** A location that has been a statistically significant hot spot for 90 percent of the time-step intervals with no discernible trend in the intensity of clustering over time.
- ***Diminishing Hot Spot:*** A location that has been a statistically significant hot spot for 90 percent of the time-step intervals, including the final time step. In addition, the intensity of clustering in each time step decreases overall, and that decrease is statistically significant.
- ***Sporadic Hot Spot:*** A statistically significant hot spot for the final time-step interval with a history of also being an on-again and off-again hot spot. Less than 90 percent of the time-step intervals have been statistically significant hot spots, and none of the time-step intervals have been statistically significant cold spots.
- ***Oscillating Hot Spot:*** A statistically significant hot spot for the final time-step interval that has a history of also being a statistically significant cold spot during a prior time step. Less than 90 percent of the time-step intervals have been statistically significant hot spots.
- ***Historical Hot Spot:*** The most recent time period is not hot, but at least 90 percent of the time-step intervals have been statistically significant hot spots.

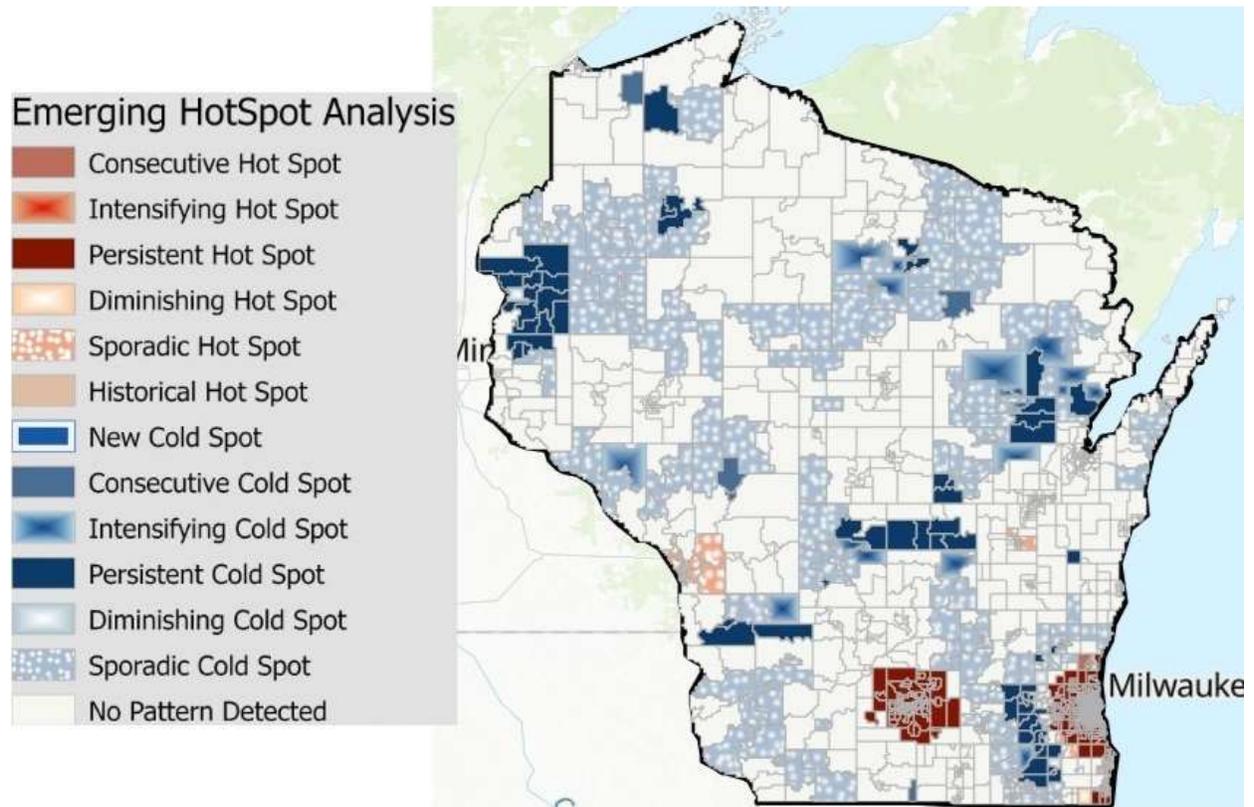
⁸ Environmental Systems Research Institute, Inc. (ESRI). (2025). How Emerging Hot Spot Analysis Works. Accessed July 15, 2025, <https://pro.arcgis.com/en/pro-app/latest/tool-reference/space-time-pattern-mining/learnmoreemerging.htm>.

- ***New Cold Spot:*** A location that is a statistically significant cold spot for the final time step and has never been a statistically significant cold spot before.
- ***Consecutive Cold Spot:*** A location with a single uninterrupted run of at least two statistically significant cold spot bins in the final time-step intervals. The location has never been a statistically significant cold spot prior to the final cold spot run and less than 90 percent of all bins are statistically significant cold spots.
- ***Intensifying Cold Spot:*** A location that has been a statistically significant cold spot for 90 percent of the time-step intervals, including the final time step. In addition, the intensity of clustering of low counts in each time step is increasing overall, and that increase is statistically significant.
- ***Persistent Cold Spot:*** A location that has been a statistically significant cold spot for 90 percent of the time-step intervals with no discernible trend in the intensity of clustering of counts over time.
- ***Diminishing Cold Spot:*** A location that has been a statistically significant cold spot for 90 percent of the time-step intervals, including the final time step. In addition, the intensity of clustering of low counts in each time step is decreasing overall, and that decrease is statistically significant.
- ***Sporadic Cold Spot:*** A statistically significant cold spot for the final time-step interval with a history of also being an on-again and off-again cold spot. Less than 90 percent of the time-step intervals have been statistically significant cold spots, and none of the time-step intervals have been statistically significant hot spots.
- ***Oscillating Cold Spot:*** A statistically significant cold spot for the final time-step interval that has a history of also being a statistically significant hot spot during a prior time step. Less than 90 percent of the time-step intervals have been statistically significant cold spots.
- ***Historical Cold Spot:*** The most recent time period is not cold, but at least 90 percent of the time-step intervals have been statistically significant cold spots.

(Source: ESRI, <https://pro.arcgis.com/en/pro-app/latest/tool-reference/space-time-pattern-mining/learnmoreemerging.htm>)

Results suggest that there are persistent hot spots of total pedestrian and bicyclist crashes in urbanized area census tracts around Milwaukee, Madison, and Kenosha (Figure A.3). Persistent cold spots are in several rural areas of the state. This pattern is generally consistent with population density across the state. The sporadic hot spots and sporadic cold spots suggest that pedestrian and bicyclist crash numbers varied from year-to-year between 2008 and 2023 in many other areas of the state.

Figure A.3. Emerging Hot Spot Analysis of Pedestrian and Bicyclist Crashes by Tract, Statewide (2008-2023)



A.3. Changes in Pedestrian and Bicyclist Crash Patterns Over Time in Milwaukee County

We separated pedestrian and bicyclist crashes to conduct a finer-grained space-time cube analysis and emerging hot spot analysis for Milwaukee County census tracts from 2008 to 2023.

We started our Milwaukee County analysis with an overview of pedestrian crash rates and bicyclist crash rates by tract. These rates were calculated by dividing the total number of reported pedestrian or bicyclist crashes during 2008-2023 by the 2022 population of the tract. For pedestrians, census tracts with the highest crash rates were concentrated in central Milwaukee County, including Downtown, the Near North Side, and Near South Side in the City of Milwaukee (Figure A.4). Parts of Wauwatosa, West Allis, Greenfield, Cudahy, and the East side of the City of Milwaukee also had higher pedestrian crash rates. For bicyclists, relatively higher crash rates were in similar areas as pedestrian crashes, though higher rates spread further from the center of the county into Glendale and Fox Point as well as more into West Allis, Greenfield, and South Milwaukee (Figure A.5).

The time-space cube analysis of pedestrian crashes showed more tracts with significant increasing trends than decreasing trends between 2008 and 2023 (Figure A.6). However, there was no clear spatial pattern among tracts that had either significant increases or decreases in pedestrian crashes over time. The time-space cube analysis of bicycle crashes mostly highlighted tracts with significant decreasing trends over time, though there were no clear spatial patterns among the tracts where bicyclist crashes decreased (Figure A.7).

Accounting for spatial relationships between nearby census tracts, the emerging hot spot analysis suggested several areas with trends in pedestrian crashes as well as bicyclist crashes. There were persistent hot spots of pedestrian crashes south of Downtown Milwaukee (the Third Ward and Walker's Point areas) and on the north side of the City of Milwaukee (Figure A.8). These were surrounded by some sporadic hot spots. Persistent pedestrian cold spots were highlighted in Fox Point and the south side of the City of Milwaukee (Tippecanoe neighborhood), and there were sporadic cold spots spread among other areas of the county. For bicyclist crashes, there were persistent and consecutive cold spots on the west side of the City of Milwaukee near Wauwatosa as well as several parts of the north side of the City of Milwaukee (Figure A.9). There were several sporadic hot spots of bicyclist crashes on the Near South Side of the City of Milwaukee.

Figure A.4. Pedestrian Crashes Per Person, Milwaukee County Census Tracts (2008-2023)

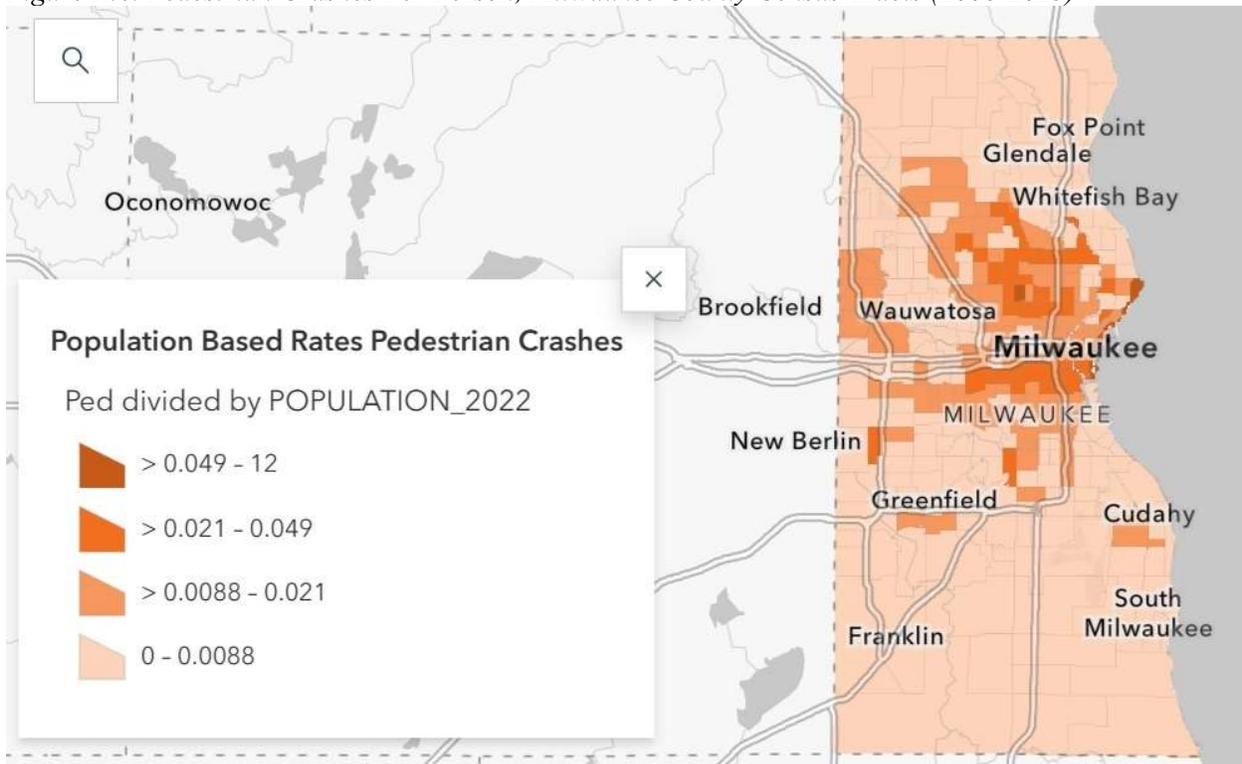


Figure A.5. Bicyclist Crashes Per Person, Milwaukee County Census Tracts (2008-2023)

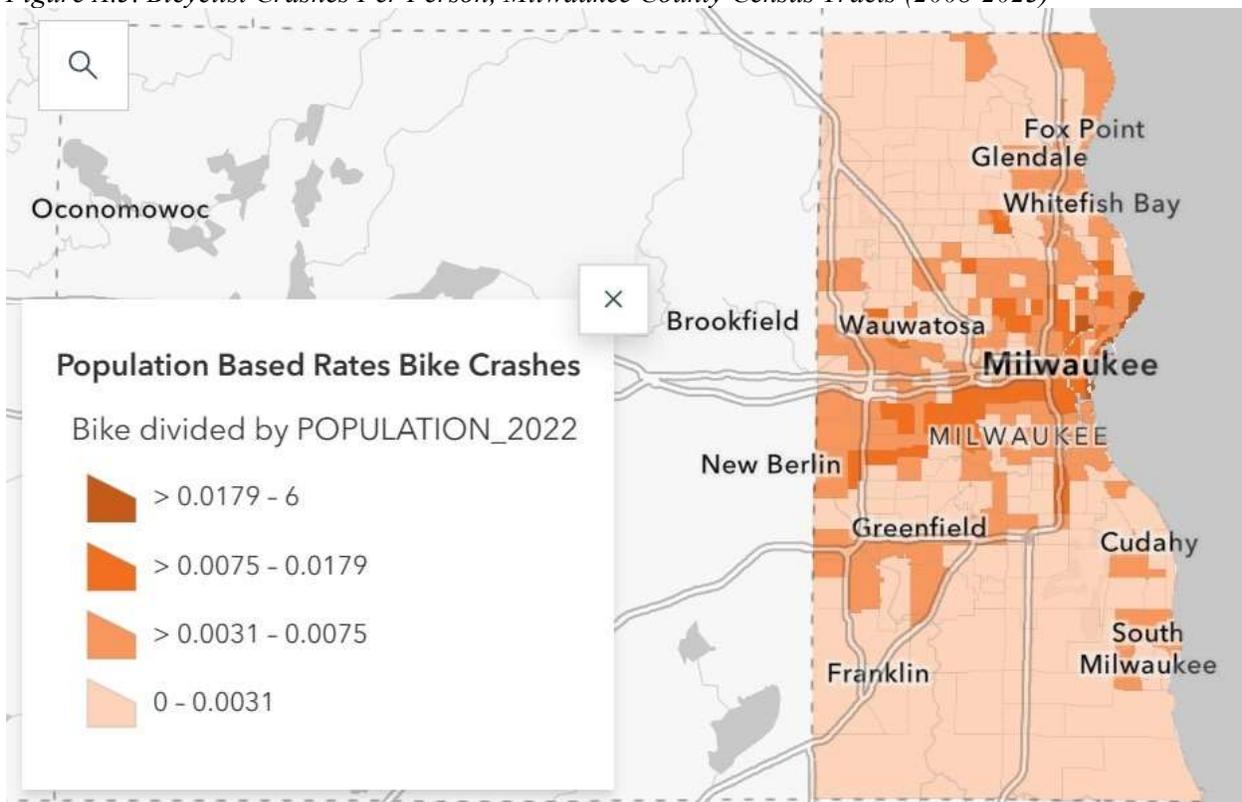


Figure A.6. Pedestrian Crash Time-Space Cube Analysis, Milwaukee County Census Tracts (2008-2023)

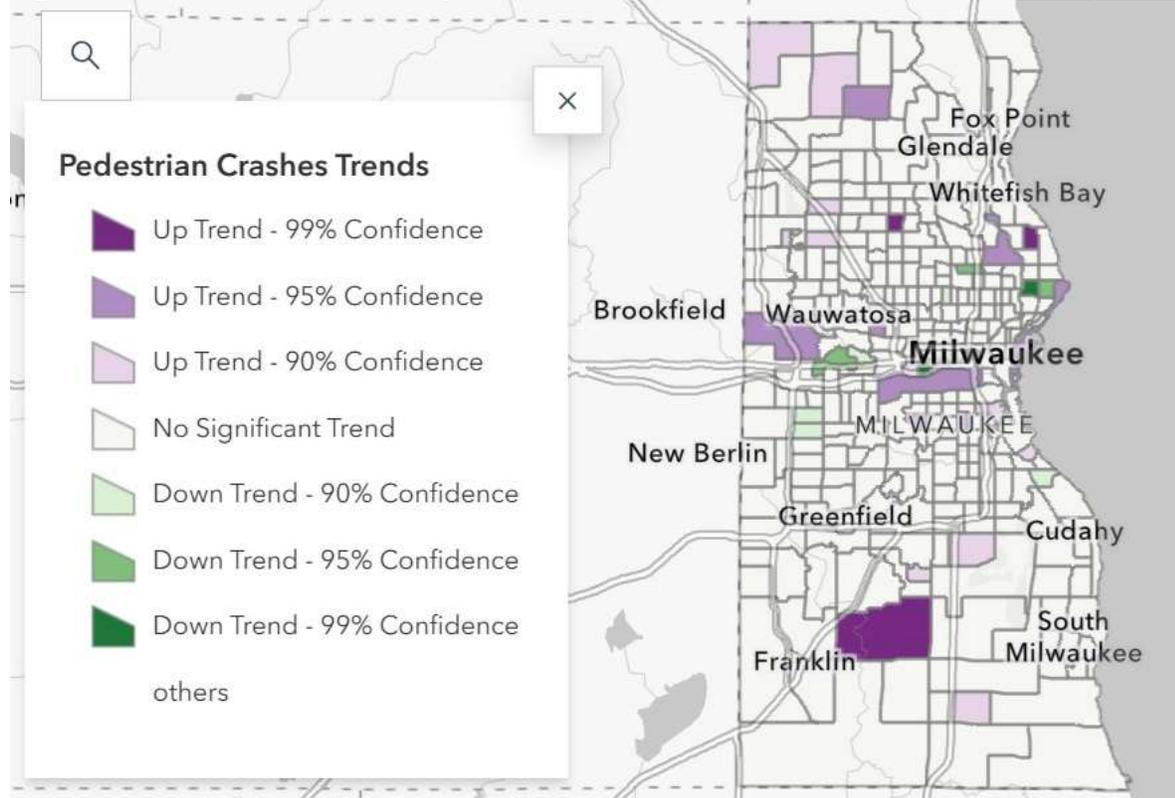


Figure A.7. Bicyclist Crash Time-Space Cube Analysis, Milwaukee County Census Tracts (2008-2023)

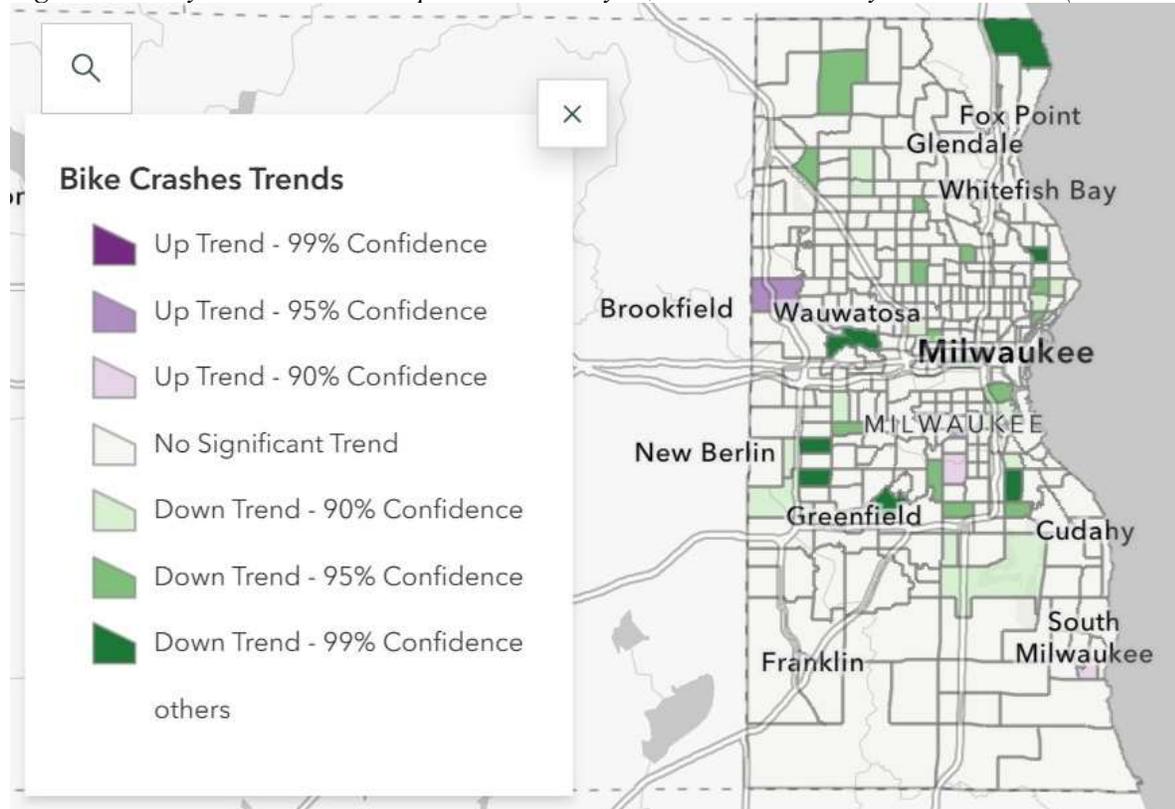


Figure A.8. Pedestrian Emerging Hot Spot Analysis, Milwaukee County Census Tracts (2008-2023)

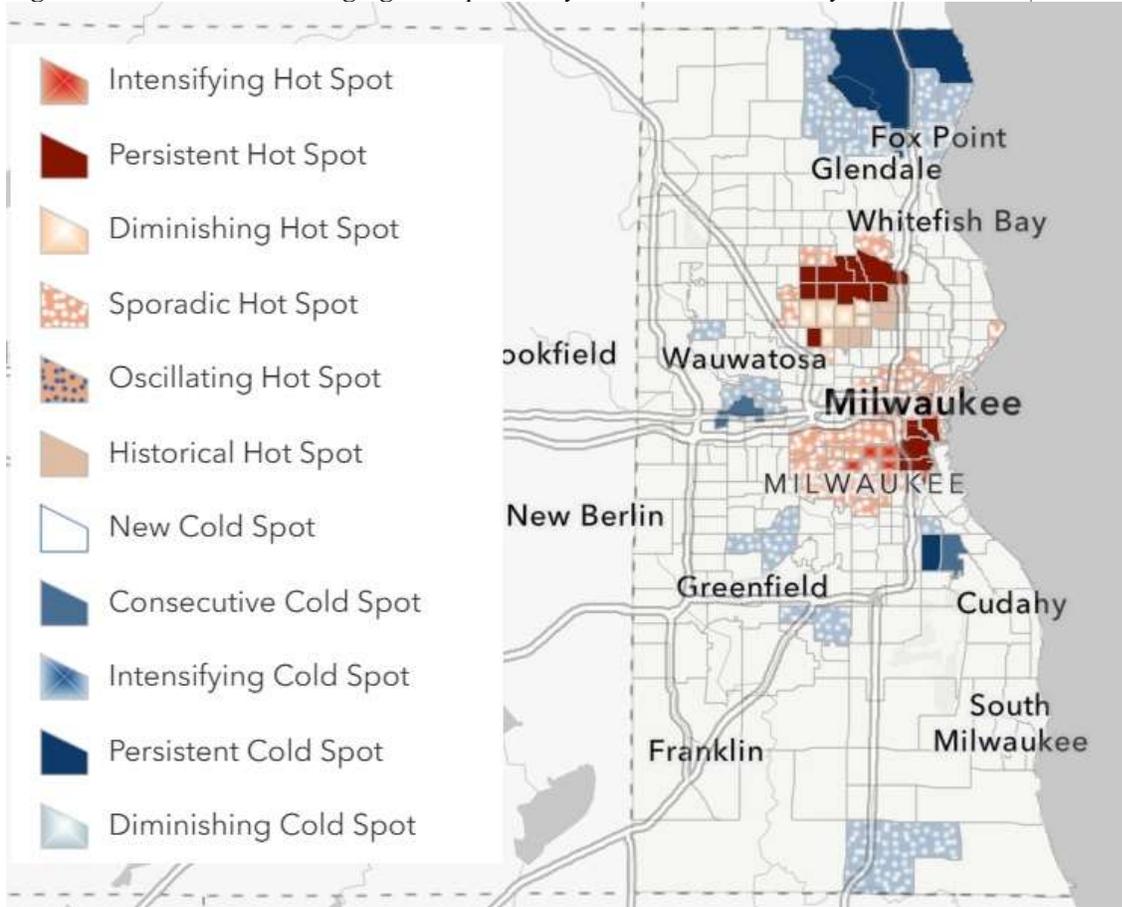
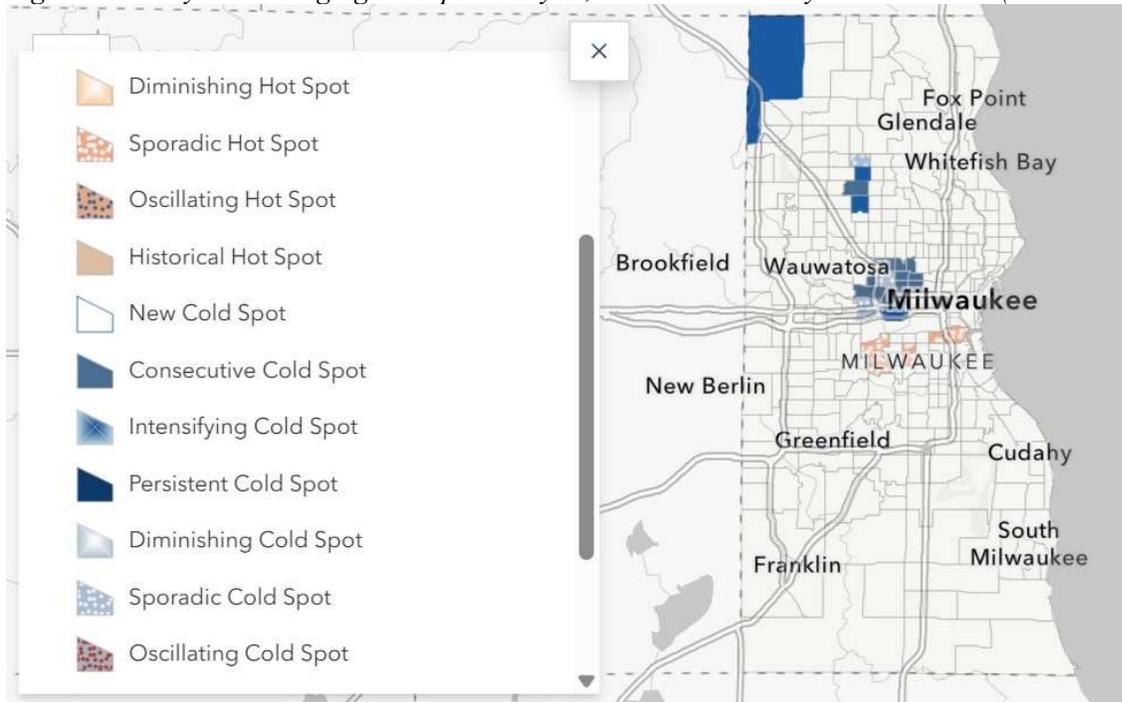


Figure A.9. Bicyclist Emerging Hot Spot Analysis, Milwaukee County Census Tracts (2008-2023)



APPENDIX B. SEQUENTIAL MODELING FRAMEWORK FOR CENSUS TRACT PEDESTRIAN CRASH FREQUENCY

This appendix includes an abbreviated summary of a paper that presents a sequential modeling framework that integrates spatial models with machine learning (ML) techniques to analyze pedestrian crash frequency at the census tract level in Wisconsin. In the first stage, two Conditional Autoregressive (CAR) models; the Poisson-Gamma CAR (P-G CAR) and Poisson-Lognormal CAR (P-L CAR) are applied to estimate the neighborhood-level determinants of pedestrian crashes. In the subsequent stage, residuals from the CAR models are analyzed using ML algorithms with SHapley Additive exPlanations (SHAP) to uncover nonlinear associations and hidden patterns not captured in the initial predictions. These analyses were led by Farheen Rukhsana with supervision from Dr. Xiao Qin and review by Dr. Robert Schneider.

A Sequential Spatial-ML Framework for Interpretable Macro-level Pedestrian Crash Modeling

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B.1. Introduction

The upward trend in pedestrian deaths in the U.S. over the past decade has raised concerns about the effectiveness of existing transportation planning strategies, roadway designs, and safety policies at protecting vulnerable road users. In response, researchers have employed a range of modeling approaches to examine the underlying factors contributing to these fatality trends. Methodologically, pedestrian crash frequency modeling has evolved from basic count models to global spatial models, more recently, to localized spatial models. However, a key limitation of these statistical models is their reliance on specific functional forms, which constrains their ability to effectively capture the high dimensionality, and complex nonlinear relationships often present in crash data.¹⁸ In contrast, Machine learning (ML) techniques have gained prominence in traffic safety research due to their effectiveness in handling complex, nonlinear relationships and accounting for unobserved data heterogeneity. Despite their advantages, ML techniques often yield inconsistent findings, creating challenges for interpretation and leaving practitioners wondering about how to translate model outputs into actionable insights.

Therefore, to make a balance between predictive performance and interpretability, this study introduced a sequential approach that integrates spatial models with ML techniques. Specifically, after applying conventional crash count models at the census tract level, we employed ML algorithms with SHapley Additive exPlanations (SHAP) to analyze residuals in order to recover the missed information in initial predictions. By rigorously evaluating model performance and interpretability, this hybrid framework leverages the strengths of both spatial and machine learning approaches to reveal the influence of neighborhood-level determinants on pedestrian crashes.

B.2. Data Collection

In this study, five years (2017–2021) of geocoded pedestrian crash data were obtained from the MV4000 crash report database within the WisTransPortal system and were spatially aggregated across 1,390 census tracts in Wisconsin.¹⁹ To capture both the frequency and severity of pedestrian crash events, two dependent variables were analyzed at the census tract level: (1) fatal and severe injury (FSI) pedestrian crashes, defined as those classified as fatal (K) or incapacitating injury (A); and (2) total pedestrian crashes, encompassing all reported pedestrian-involved incidents.

¹⁸ Ali, A., Jayaraman, R., Azar, E., & Maalouf, M. (2024). A comparative analysis of machine learning and statistical methods for evaluating building performance: A systematic review and future benchmarking framework. *Building and Environment*, 252, 111268. <https://doi.org/10.1016/j.buildenv.2024.111268>

¹⁹ Wisconsin Traffic Operations and Safety Laboratory. (2025). The WisTransPortal System. Accessed July 24, 2025, <https://transportal.cee.wisc.edu/>

B.3. Methodology

In the first stage of analysis, two spatial models, Poisson-Gamma conditional autoregressive (P-G CAR) and Poisson Lognormal conditional autoregressive (P-L CAR), were estimated to capture the relationships between explanatory variables and FSI crashes and total pedestrian crash counts, respectively. The unexplained variation from these models is expressed as:

$$r_i = y_i - \widehat{y}_i^{\text{CAR}} \quad (1)$$

where y_i is the observed FSI and total pedestrian crashes, $\widehat{y}_i^{\text{CAR}}$ is the predicted value from the CAR models for census tract i .

In the second stage, these residuals were modeled using Random Forest and XGBoost with SHAP employed to interpret the contribution of input features in explaining the residual variation not captured by the CAR models. The final combined prediction integrating both CAR and ML components is given by:

$$\widehat{y}_i^F = \widehat{y}_i^{\text{CAR}} + r_i^{(\text{ML})} \quad (2)$$

where \widehat{y}_i^F denotes the final predicted crash count and after integrating both CAR models with ML approaches, $r_i^{(\text{ML})}$ is the predicted residual from the ML models.

B.4. Findings

Table B.1 presents the results of CAR models for both FSI and total pedestrian crashes. The results show that exposure variable, for example, population density exhibits a strong positive association with both FSI and total pedestrian crashes. Moreover, other proxy exposure variables have been analyzed to represent overall pedestrian activity that demonstrates a positive relationship with both levels of pedestrian crashes. After controlling pedestrian exposure with proxy variables, the models show significant associations between several other variables and pedestrian crashes. Specifically, the proportions of Black and Hispanic residents within a tract are positively linked with the number of FSI and total pedestrian crashes per tract. Further, a higher proportion of unemployed individuals in the labor force is significantly and positively associated with total pedestrian crashes, while no statistically significant association is found for FSI crashes. In contrast, median household income is negatively associated with both types of crashes, indicating that lower-income areas tend to experience a disproportionately higher incidence of FSI and total pedestrian crashes.

Table B.1. Results of CAR Models

Variables	P-G CAR Model				P-L CAR Model			
	FSI		Total		FSI		Total	
	β	Exp(β)	β	Exp(β)	β	Exp(β)	β	Exp(β)
Intercept	1.385***	3.994	2.685***	14.659	1.284***	3.61	2.54***	12.6
Pop Density	0.196***	1.216	0.282***	1.325	0.199***	1.22	0.281***	1.32
Proxy variables for exposures								
Total POP	0.353***	1.423	0.277***	1.319	0.357***	1.43	0.279***	1.32
Total Jobs	0.227***	1.255	0.329***	1.390	0.224***	1.25	0.313***	1.37
% Transit	0.107***	1.113	0.043	1.044	0.104***	1.11	0.038	1.04
Demographic and socioeconomic features								
%Black	0.199***	1.221	0.185***	1.203	0.199***	1.22	0.186***	1.20
% Hispanic	0.067**	1.070	0.109***	1.115	0.065**	1.07	0.107***	1.11
Median income	-0.355***	0.701	-0.321***	0.726	-0.363***	0.70	-0.33***	0.72
%Unemployed	0.047	1.05	0.070**	1.072	0.047	1.05	0.073**	1.08
% Retail	0.078**	1.081	0.125***	1.134	0.079**	1.08	0.124***	1.13
Roadway characteristics								
AADT>20k	0.118***	1.117	0.050*	1.051	0.115***	1.12	0.049*	1.05
Unmeasured spatial effect								
Average spatial autocorrelation	-0.0003	1	-0.002	0.998	-0.0002	1.00	-0.0007	1.00

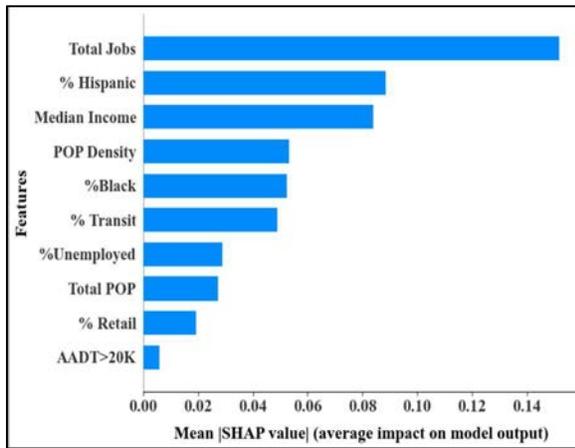
Note: Variables are statistically significant at the 99.9% (***), 99% (**), and 95% (*) confidence levels.

Table B.2 shows that the integration of ML techniques, specifically RF moderately improved the performance of both CAR models, reducing RMSE and MAE value. Furthermore, the SHAP bar plot illustrates the average magnitude of each variable’s contribution to the model output and offers a ranked assessment of the most to least influential predictors.

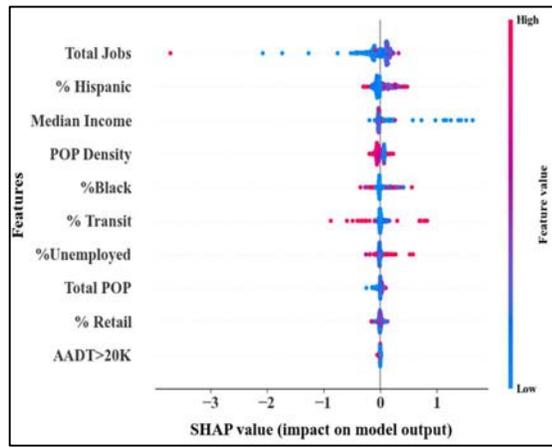
Table B.2. Impact of ML on Model Predictive Performance

Models	FSI		Total	
	RMSE	MAE	RMSE	MAE
P-G CAR	1.52	1.11	3.19	1.92
P-G CAR+ XGBoost	1.56	1.10	2.97	1.84
P-G CAR+ RF	1.50	1.07	2.85	1.78
P-L CAR	1.53	1.09	3.09	1.93
P-L CAR+ XGBoost	1.53	1.09	3.05	1.86
P-L CAR+ RF	1.52	1.08	2.95	1.84

Figure B.1 Random Forest with SHAP on CAR residuals (FSI Pedestrian Crashes)

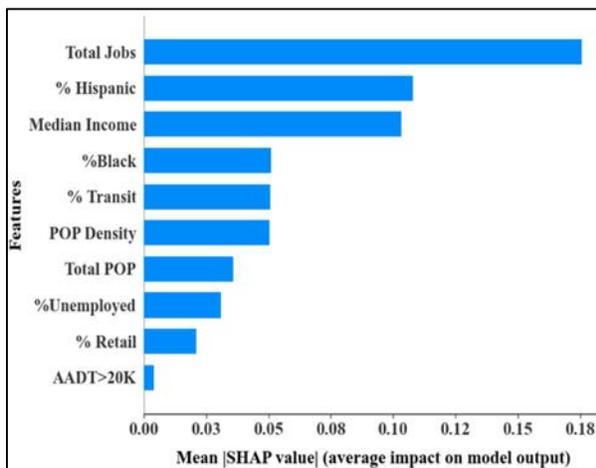


(a)(i) Bar plot

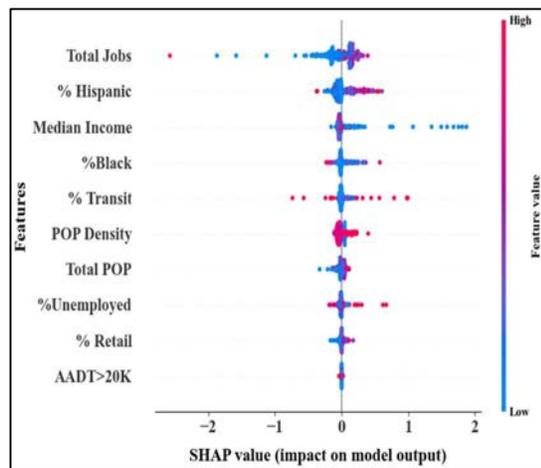


(a)(ii) Beeswarm plot

(a) SHAP values for RF with P-G CAR



(b)(i) Bar plot



(b)(ii) Beeswarm plot

(b) SHAP values for RF with P-L CAR

Figure B.1 shows that total jobs is the most impactful factor contributing to residual variation in both CAR models for FSI crashes, as identified by the RF. Moreover, the SHAP Beeswarm plot visualizes feature contributions by showing both their importance and direction of influence, with each dot representing an instance positioned by its SHAP value and colored by the feature's original magnitude (red = high, blue = low). For example, Figure B.1 shows that tracts with fewer jobs have predominantly negative SHAP values, indicating lower residual predictions in areas with less employment.

B.5. Conclusion

This study developed a sequential framework integrating spatial and ML approaches to explore the influence of neighborhood-related determinants on pedestrian crashes. Our findings demonstrate that the P-G CAR model outperforms the P-L CAR model, and the integration with ML techniques, specifically RF, further enhances the predicted performance of P-G CAR model.

The study highlights the strong positive association between pedestrian crash risk and neighborhood characteristics such as population density, proportion of Black and Hispanic population, unemployment, transit use, and retail employment, while showing the negative effect of higher household income emphasizing the need for equity-focused safety interventions. Moreover, the SHAP analysis reveals that features such as total jobs, percentage of Hispanic residents, and population density are key contributors in explaining residual variations across both models. Nonetheless, this study has limitations. It relies on proxy measures for pedestrian exposure, lacks behavioral attributes and transportation-infrastructure-specific data, and employs widely used machine learning techniques.

APPENDIX C. INTERVIEW PROTOCOL

Changes in Pedestrian and Bicyclist Fatality Rates

Professional Interview Protocol

Center for Pedestrian and Bicyclist Safety University Transportation Center

University of Wisconsin-Milwaukee

Robert J. Schneider, PI; Henry Barbee, Graduate Student Researcher

Approved by University of Wisconsin-Milwaukee IRB, January 24, 2025

IRB #: 25.155

We will conduct interviews with professionals in several local, regional, and state jurisdictions (e.g., transportation planners or engineers, community advocates, policymakers) to document transportation system policy, budget, project implementation, and other contextual changes (e.g., population growth/decline, development activity, pedestrian and bicyclist activity, automobile traffic patterns) that may be associated with pedestrian and bicyclist safety changes. Importantly, we will explore why they think safety outcomes have changed in their communities.

We hypothesize that communities that have made the most progress improving pedestrian and bicyclist safety have done some or all of the following: 1) communicated that pedestrian and bicyclist safety are critical community issues and set aggressive timelines to reduce pedestrian and bicycle fatalities to zero; 2) increased their agency budget for traffic safety improvements significantly; 3) added more pedestrian and bicycle facilities, reduced roadway design speeds, and lowered posted speed limits in high-injury corridors; 4) increased walking and bicycling mode shares; 5) increased traffic safety educational messaging; 6) increased traffic safety enforcement; or 7) taken other actions that we do not yet anticipate being associated with success.

Our alternative hypotheses are that communities with pedestrian and bicyclist fatality rate reductions: 1) have lower-risk characteristics (e.g., less automobile-dominated built environments; wealthier and more educated residents) or 2) have simply been lucky, and improvements have occurred randomly (randomness that could result in more fatalities in the future).

Insights from our interview process will provide important lessons for communities seeking to make progress towards zero pedestrian and bicyclist fatalities.

Prior to conducting the interview, we will send the potential interviewees the results from our analysis of pedestrian and bicyclist commute-to-work and fatality rate changes in their specific jurisdictions. We will ask about these data during our interview.

Interview Guide and Questions

Over the last two decades, the US Department of Transportation and many state and local governments have established goals to increase overall levels of pedestrian and bicycle activity and to reduce pedestrian and bicyclist traffic fatalities. This interview is designed to gain insights from local and state practitioners about changes to pedestrian and bicyclist fatality outcomes in their communities, particularly during the decade of the 2010s. Thank you for participating and sharing your thoughts with us.

1) Please state your name, title and role that you serve in your organization, including how your role is related to pedestrian and bicycle transportation.

Before we discuss pedestrian and bicyclist fatalities, we want to ask briefly about changes in pedestrian and bicyclist activity levels in your community, which is important context for understanding trends in the numbers of pedestrian or bicyclists who were killed.

2) We have data on changes in pedestrian and bicyclist commuting to work from the American Community Survey. In your jurisdiction, pedestrian commuting increased/decreased by X% and bicycle commuting increased/decreased by Y% between the 2008-2012 and 2018-2022 periods. Do you think that overall pedestrian or bicyclist activity (including walking or bicycling for shopping, social activities, school, etc.) followed a similar trend? If not, why not? Why do you think that your jurisdiction's trends in pedestrian or bicyclist activity levels occurred? Are there any strong seasonal or special event patterns of pedestrian or bicyclist activity in your community (e.g., school, college, festivals), including among tourists? How have overall population and job levels changed in your community between 2008-2012 and 2018-2022?

3) Now let's move on to pedestrian and bicyclist safety. Our research team collected data on changes in pedestrian and bicyclist fatality rates (fatalities per population) in your jurisdiction between 2008-2012 and 2018-2022. Tell the participant that in their jurisdiction, pedestrian fatality rates increased/decreased by X% and bicyclist fatality rates increased/decreased by Y% between the 2008-2012 and 2018-2022 periods. Why do you think that these trends occurred?

4) Across the US, we noticed a trend of pedestrian fatalities increasing significantly during the 3-6am time period on weekdays. Do you think that this is happening in your community? If so, why?

The following questions provide information about the broader context for pedestrian and bicyclist safety changes in your community.

5) What community-level policies have been adopted in your jurisdiction since 2010 that are either directly or indirectly intended to improve pedestrian or bicyclist safety? When were these policies adopted? Do you think that they have been implemented successfully? If any barriers have slowed the implementation of these policies, please describe them.

6) What advocacy efforts have been initiated among local community members or community groups to either directly or indirectly improve pedestrian or bicyclist safety? Were there any actions taken that were not specifically intended to improve pedestrian or bicyclist safety, but that you think helped?

7) *What socioeconomic changes have occurred in your community (or within specific parts of your community) since 2010 (e.g., job shifts, poverty shifts, educational attainment shifts, age shifts)? Do you think these relate to pedestrian or bicyclist safety outcomes? If so, how?*

8) *What land use and development changes have occurred in your community since 2010 (e.g., zoning changes, new development, redevelopment, vacancies, demolition, parking lot changes)? How has public transit service and ridership changed in your community since 2010? Do you think these land use or transit service changes relate to pedestrian or bicyclist safety outcomes?*

The following questions are about actions that your organization has taken to try to improve pedestrian and bicyclist safety since 2010.

9) *What changes have been implemented within your organization (e.g., staffing, budget, grants) to either directly or indirectly improve pedestrian or bicyclist safety?*

10) *Please provide some examples of engineering/roadway design changes, education programs, or enforcement programs that were intended to improve pedestrian or bicyclist safety in your community.*

11) *How has your organization communicated the pedestrian or bicyclist safety benefits of policy or project changes with the public? Have elected officials in your community helped communicate the importance of pedestrian or bicyclist safety? How has the public reacted to policy or project changes that have been implemented in your community?*

12) *What challenges has your organization faced when trying to a) create institutional changes within your own organization; b) make engineering, education, or enforcement changes in your community; or c) communicate the pedestrian or bicyclist safety benefits of certain actions to community members?*

APPENDIX D. BACKGROUND DATA TABLES FOR CHARTS

This appendix includes tables with the background data corresponding with the charts in the report. For example, Table D.1 in this appendix corresponds with Figure 1 in the report. Table D.2 corresponds with Figure 2, and so on.

Table D.1. State-Level Changes in Fatal Pedestrian Crashes, 2008-2021

	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
California	602	563	581	618	679	720	713	809	884	903	931	967	975	1079
Colorado	47	52	40	48	73	54	64	65	83	92	92	76	93	83
Massachusetts	75	46	66	63	80	78	78	83	89	75	78	79	63	81
Minnesota	25	39	35	39	37	34	16	41	56	39	39	44	45	54
New York	273	279	279	263	305	325	265	300	302	253	255	267	234	255
Oregon	51	39	60	48	60	51	56	70	75	73	79	85	78	88
Pennsylvania	143	134	149	152	163	149	160	151	174	148	203	153	145	182
Washington	61	61	64	67	74	48	73	83	88	107	102	104	108	141
Wisconsin	59	40	56	62	48	42	44	55	53	56	55	52	50	49
Grand Total	1336	1253	1330	1360	1519	1501	1469	1657	1804	1746	1834	1827	1791	2012

Table D.2. State-Level Changes in Fatal Bicyclist Crashes, 2008-2021

	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
California	116	100	105	122	138	152	130	145	147	144	160	145	135	123
Colorado	11	10	8	8	13	12	10	14	16	16	21	21	14	15
Massachusetts	10	6	8	5	15	7	9	15	10	12	4	5	10	7
Minnesota	13	10	9	5	7	7	5	10	7	5	6	10	10	8
New York	41	28	34	55	45	38	46	37	41	47	29	46	52	42
Oregon	11	7	7	15	10	3	7	7	11	10	9	12	14	18
Pennsylvania	8	17	21	11	17	11	19	16	16	21	18	16	22	24
Washington	9	10	6	12	13	11	8	15	20	15	15	9	14	14
Wisconsin	9	7	9	12	11	10	4	14	11	7	5	14	12	9
Grand Total	228	195	207	245	269	251	238	273	279	277	267	278	283	260

Table D.3. Change in Pedestrian Crashes in Nine States by Injury Severity Level, 2008-2021

	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Fatal injury (K)	1336	1253	1330	1360	1519	1501	1469	1657	1804	1746	1834	1827	1791	2012
Non-fatal injury (A)	5050	4933	4886	4945	5187	4968	4907	5020	5477	5564	5758	6022	4917	5794
Moderate injury (B)	11669	11601	11537	11369	12035	11548	11774	11674	12651	12702	12918	13327	9894	10780
Minor or possible injury (C)	18778	18934	19607	19533	19394	19627	19325	19169	19329	19899	19541	17988	11248	11870
Grand Total	36833	36721	37360	37207	38135	37644	37475	37520	39261	39911	40051	39164	27850	30456

Table D.4. Change in Bicyclist Crashes in Nine States by Injury Severity Level, 2008-2021

	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Fatal injury (K)	228	195	207	245	269	251	238	273	279	277	267	278	283	260
Non-fatal injury (A)	1925	1933	1927	1978	2070	1971	1951	2020	2026	1964	1982	2051	1963	2110
Moderate injury (B)	10155	10287	10913	11040	11639	11127	10844	10612	10244	9785	9423	9313	7774	8235
Minor or possible injury (C)	10107	10255	10943	11389	11619	11452	11026	11024	10557	10083	9625	8840	6911	7167
Grand Total	22415	22670	23990	24652	25597	24801	24059	23929	23106	22109	21297	20482	16931	17772

Table D.5. Change in Wisconsin Pedestrian Injury Severity, 2008-2023

	K-Fatal	A-Severe	B-Minor	C-Possible	Total Known Injury Severity	Other/Unknown
2008	59	310	723	570	1662	87
2009	40	282	685	559	1566	89
2010	57	275	678	606	1616	89
2011	65	270	677	588	1600	86
2012	47	274	717	606	1644	77
2013	42	256	722	610	1630	110
2014	45	228	628	607	1508	102
2015	57	259	729	591	1636	71
2016	52	254	778	522	1606	113
2017	68	288	743	407	1506	100
2018	63	276	714	422	1475	101
2019	62	277	694	401	1434	99
2020	58	254	525	270	1107	80
2021	64	305	637	327	1333	90
2022	84	257	621	317	1279	99
2023	73	254	590	346	1263	89
Total	936	4319	10861	7749	23865	1482
2008-2012	268	1411	3480	2929	8088	428
2017-2021	315	1400	3313	1827	6855	470
Avg 2008-2012 Population	5687219	5687219	5687219	5687219	5687219	5687219
Avg 2017-2021 Population	5871661	5871661	5871661	5871661	5871661	5871661
Pedestrians per year per 100,000 pop, 2008-2012	0.94	4.96	12.24	10.30	28.44	1.51
Pedestrians per year per 100,000 pop, 2017-2021	1.07	4.77	11.28	6.22	23.35	1.60

Table D.6. Change in Wisconsin Bicyclist Injury Severity, 2008-2023

	K-Fatal	A-Severe	B-Minor	C-Possible	Total Known Injury Severity	Other/Unknown
2008	9	121	586	374	1090	81
2009	7	116	566	362	1051	92
2010	9	109	626	368	1112	85
2011	12	107	588	338	1045	102
2012	11	114	609	401	1135	107
2013	10	86	515	327	938	101
2014	4	95	480	329	908	110
2015	15	76	513	357	961	99
2016	11	109	485	317	922	87
2017	7	76	533	220	836	80
2018	4	76	478	201	759	105
2019	14	81	400	194	689	81
2020	12	74	340	129	555	70
2021	9	87	377	136	609	93
2022	14	71	374	148	607	73
2023	7	92	424	183	706	96
Total	155	1490	7894	4384	13923	1462
2008-2012	48	567	2975	1843	5433	467
2017-2021	46	394	2128	880	3448	429
Avg 2008-2012 Population	5687219	5687219	5687219	5687219	5687219	5687219
Avg 2017-2021 Population	5871661	5871661	5871661	5871661	5871661	5871661
Bicyclists per year per 100,000 pop, 2008-2012	0.17	1.99	10.46	6.48	19.11	1.64
Bicyclists per year per 100,000 pop, 2017-2021	0.16	1.34	7.25	3.00	11.74	1.46

Table D.7. Wisconsin Pedestrian Fatalities Plus Severe Injuries by Age Category, 2008-2023

	Age 1-14	Age 15-19	Age 20-24	Age 25-34	Age 35-44	Age 45-54	Age 55-64	Age 65-74	Age 75+	Total Known Age	Unknown Age
2008	72	40	30	56	41	54	30	15	31	369	
2009	44	40	34	48	34	51	30	15	26	322	
2010	56	37	42	34	30	45	42	18	25	329	3
2011	47	30	26	42	40	38	35	36	40	334	1
2012	51	31	37	38	31	50	37	23	22	320	1
2013	42	19	32	49	23	38	42	19	30	294	4
2014	35	30	31	38	33	27	40	19	20	273	
2015	35	28	26	54	31	42	42	21	34	313	3
2016	44	31	23	38	44	35	43	24	24	306	
2017	41	29	35	44	41	37	57	37	32	353	3
2018	44	24	27	42	39	46	54	35	26	337	2
2019	44	23	28	53	47	36	40	42	24	337	2
2020	20	22	25	57	46	40	53	30	19	312	
2021	32	33	20	48	67	53	59	33	21	366	3
2022	28	22	28	48	50	37	51	47	28	339	2
2023	45	22	21	41	50	42	48	40	18	327	
Total	680	461	465	730	647	671	703	454	420	5231	24
2008-2012	270	178	169	218	176	238	174	107	144	1674	5
2017-2021	181	131	135	244	240	212	263	177	122	1705	10
Avg 2008-2012 Population	1098568	399788	388572	719728	727364	866941	702596	405090	378572	5687219	
Avg 2017-2021 Population	1062824	387828	393324	735155	728714	732579	834159	599187	397891	5871661	
Pedestrians per year per 100,000 pop, 2008-2012	4.92	8.90	8.70	6.06	4.84	5.49	4.95	5.28	7.61	5.89	
Pedestrians per year per 100,000 pop, 2017-2021	3.41	6.76	6.86	6.64	6.59	5.79	6.31	5.91	6.13	5.81	

Table D.8. Drivers involved in Wisconsin Crashes producing a Fatal or Severe Pedestrian Injury by Driver Age Category, 2008-2023

	Age 1-14	Age 15-19	Age 20-24	Age 25-34	Age 35-44	Age 45-54	Age 55-64	Age 65-74	Age 75+	Total Known Age	Unknown Age
2008		52	53	71	55	43	33	16	9	332	71
2009		46	43	60	39	49	31	11	18	297	50
2010	1	36	48	64	39	58	43	17	21	327	43
2011		38	35	60	44	41	34	18	24	294	65
2012	1	29	37	56	44	48	45	21	17	298	51
2013		23	38	42	39	42	35	20	26	265	56
2014	2	20	28	54	37	45	33	16	14	249	45
2015		25	44	66	47	31	39	25	18	295	73
2016		26	26	57	44	36	38	23	15	265	69
2017	1	26	40	71	43	44	32	27	21	305	50
2018		31	35	54	49	38	43	22	17	289	51
2019	1	36	28	61	61	39	33	20	23	302	47
2020	2	19	35	68	45	30	39	18	11	267	52
2021	4	27	41	63	42	35	25	17	15	269	60
2022		18	33	62	50	56	34	24	18	295	53
2023	1	27	32	53	39	54	34	23	21	284	59
Total	13	479	596	962	717	689	571	318	288	4633	895
2008-2012	2	201	216	311	221	239	186	83	89	1548	280
2017-2021	8	139	179	317	240	186	172	104	87	1432	260
Avg 2008-2012 Population	1098568	399788	388572	719728	727364	866941	702596	405090	378572	5687219	
Avg 2017-2021 Population	1062824	387828	393324	735155	728714	732579	834159	599187	397891	5871661	
Drivers per year per	0.04	10.06	11.12	8.64	6.08	5.51	5.29	4.10	4.70	5.44	

100,000 pop, 2008-2012											
Drivers per year per 100,000 pop, 2017-2021	0.15	7.17	9.10	8.62	6.59	5.08	4.12	3.47	4.37	4.88	

Table D.9. Wisconsin Bicyclist Fatalities Plus Severe Injuries by Age Category, 2008-2023

	Age 1-14	Age 15-19	Age 20-24	Age 25-34	Age 35-44	Age 45-54	Age 55-64	Age 65-74	Age 75+	Total Known Age	Unknown Age
2008	36	16	17	14	15	17	12	2		129	1
2009	43	13	10	7	13	22	11	4		123	
2010	33	20	13	11	9	16	10	5	1	118	
2011	23	19	14	11	11	11	17	7	6	119	
2012	20	18	14	18	14	20	17	3	1	125	
2013	22	12	10	5	8	17	15	5	2	96	
2014	21	12	8	11	10	16	11	6	4	99	
2015	17	9	13	10	12	13	11	5	1	91	
2016	22	10	11	11	12	20	21	10	2	119	1
2017	17	3	5	14	12	9	13	7	1	81	2
2018	17	7	9	8	3	12	12	7	5	80	
2019	13	9	7	15	8	9	18	14	2	95	
2020	13	5	4	9	13	18	9	10	5	86	
2021	11	12	4	13	8	17	18	8	5	96	
2022	14	11	2	7	9	10	17	12	3	85	
2023	15	8	5	18	9	11	18	13	1	98	1
Total	337	184	146	182	166	238	230	118	39	1640	5
2008-2012	155	86	68	61	62	86	67	21	8	614	1
2017-2021	71	36	29	59	44	65	70	46	18	438	2
Avg 2008-2012 Population	1098568	399788	388572	719728	727364	866941	702596	405090	378572	5687219	
Avg 2017-2021 Population	1062824	387828	393324	735155	728714	732579	834159	599187	397891	5871661	
Bicyclists per year per 100,000 pop, 2008-2012	2.82	4.30	3.50	1.70	1.70	1.98	1.91	1.04	0.42	2.16	
Bicyclists per year per 100,000 pop, 2017-2021	1.34	1.86	1.47	1.61	1.21	1.77	1.68	1.54	0.90	1.49	

Table D.10. Drivers involved in Wisconsin Crashes producing a Fatal or Severe Bicyclist Injury by Driver Age Category, 2008-2023

	Age 1-14	Age 15-19	Age 20-24	Age 25-34	Age 35-44	Age 45-54	Age 55-64	Age 65-74	Age 75+	Total Known Age	Unknown Age
2008	1	18	12	22	24	11	16	9	5	118	10
2009		10	15	27	11	23	12	8	9	115	9
2010		12	14	23	16	21	15	5	5	111	5
2011		13	12	23	12	18	17	9	7	111	6
2012	1	8	18	22	19	18	10	14	5	115	11
2013		6	10	21	13	14	12	5	8	89	7
2014	2	4	19	19	12	12	17	4	6	95	6
2015		5	10	13	16	12	12	8	6	82	7
2016		6	23	13	15	13	14	10	14	108	10
2017		3	7	18	13	16	9	8	4	78	5
2018		2	8	20	11	12	7	10	6	76	6
2019	0	6	7	19	18	12	15	9	5	91	8
2020		9	7	17	8	11	8	9	6	75	7
2021	0	10	11	17	14	10	14	6	6	88	8
2022		7	5	18	12	8	9	13	4	76	8
2023	0	3	8	19	16	11	16	14	6	93	7
Total	4	122	186	311	230	222	203	141	102	1521	120
2008-2012	2	61	71	117	82	91	70	45	31	570	41
2017-2021	0	30	40	91	64	61	53	42	27	408	34
Avg 2008-2012 Population	1098568	399788	388572	719728	727364	866941	702596	405090	378572	5687219	
Avg 2017-2021 Population	1062824	387828	393324	735155	728714	732579	834159	599187	397891	5871661	
Drivers per year per 100,000 pop, 2008-2012	0.04	3.05	3.65	3.25	2.25	2.10	1.99	2.22	1.64	2.00	
Drivers per year per 100,000 pop, 2017-2021	0.00	1.55	2.03	2.48	1.76	1.67	1.27	1.40	1.36	1.39	

Table D.11. Wisconsin Pedestrian Fatalities Plus Severe Injuries by Sex, 2008-2023

	Female	Male	Total Known Sex	Other/Unknown Sex
2008	158	232	390	
2009	141	202	343	
2010	141	204	345	1
2011	159	197	356	
2012	140	198	338	1
2013	132	181	313	
2014	123	171	294	
2015	125	196	321	2
2016	157	166	323	
2017	157	214	371	3
2018	148	197	345	1
2019	142	210	352	2
2020	122	197	319	1
2021	199	218	417	2
2022	133	220	353	1
2023	135	207	342	
Total	2312	3210	5522	14
2008-2012	739	1033	1772	2
2017-2021	768	1036	1804	9
Avg 2008-2012 Population	2864948	2822271	5687219	
Avg 2017-2021 Population	2934040	2937621	5871661	
Pedestrians per year per 100,000 pop, 2008-2012	5.16	7.32	6.23	
Pedestrians per year per 100,000 pop, 2017-2021	5.24	7.05	6.14	

Table D.12. Drivers involved in Wisconsin Crashes producing a Fatal or Severe Pedestrian Injury by Driver Sex, 2008-2023

	Female	Male	Total Known Sex	Other/Unknown Sex
2008	133	205	338	65
2009	118	183	301	46
2010	125	204	329	41
2011	99	199	298	61
2012	122	176	298	51
2013	108	158	266	55
2014	91	160	251	43
2015	118	179	297	71
2016	109	159	268	66
2017	122	184	306	49
2018	97	192	289	51
2019	102	201	303	46
2020	81	187	268	51
2021	101	166	267	62
2022	114	181	295	53
2023	100	185	285	58
Total	1740	2919	4659	869
2008-2012	597	967	1564	264
2017-2021	503	930	1433	259
Avg 2008-2012 Population	2864948	2822271	5687219	
Avg 2017-2021 Population	2934040	2937621	5871661	
Drivers per year per 100,000 pop, 2008-2012	4.17	6.85	5.50	
Drivers per year per 100,000 pop, 2017-2021	3.43	6.33	4.88	

Table D.13. Wisconsin Bicyclist Fatalities Plus Severe Injuries by Sex, 2008-2023

	Female	Male	Total Known Sex	Other/Unknown Sex
2008	31	104	135	1
2009	31	95	126	1
2010	31	88	119	1
2011	31	90	121	3
2012	34	96	130	0
2013	27	71	98	0
2014	23	80	103	0
2015	19	72	91	0
2016	32	91	123	0
2017	24	59	83	0
2018	18	64	82	0
2019	26	72	98	0
2020	18	71	89	0
2021	15	81	96	0
2022	26	59	85	0
2023	18	81	99	0
Total	404	1274	1678	6
2008-2012	158	473	631	6
2017-2021	101	347	448	0
Avg 2008-2012 Population	2864948	2822271	5687219	
Avg 2017-2021 Population	2934040	2937621	5871661	
Bicyclists per year per 100,000 pop, 2008-2012	1.10	3.35	2.22	
Bicyclists per year per 100,000 pop, 2017-2021	0.69	2.36	1.53	

Table D.14. Drivers involved in Wisconsin Crashes producing a Fatal or Severe Bicyclist Injury by Driver Sex, 2008-2023

	Female	Male	Total Known Sex	Other/Unknown Sex
2008	46	73	119	8
2009	36	81	117	7
2010	46	67	113	3
2011	55	56	111	6
2012	46	69	115	11
2013	39	50	89	7
2014	35	58	93	6
2015	36	47	83	6
2016	42	67	109	9
2017	26	52	78	5
2018	34	42	76	6
2019	35	56	91	8
2020	31	45	76	6
2021	27	62	89	8
2022	27	49	76	8
2023	34	59	93	7
Total	595	933	1528	111
2008-2012	229	346	575	35
2017-2021	153	257	410	33
Avg 2008-2012 Population	2864948	2822271	5687219	
Avg 2017-2021 Population	2934040	2937621	5871661	
Drivers per year per 100,000 pop, 2008-2012	1.60	2.45	2.02	
Drivers per year per 100,000 pop, 2017-2021	1.04	1.75	1.40	

Table D.15. Wisconsin Pedestrian Fatalities Plus Severe Injuries by Race and Ethnicity, 2021-2023

	Asian	Black	Native American	Hispanic	White	Total Known Race	Unknown Race
2021	6	56	2	34	198	296	123
2022	5	55	2	23	222	307	47
2023	8	82	4	14	212	320	22
Total	19	193	8	71	632	923	192
2021-2023	19	193	8	71	632	923	192
							Two or more
Avg 2018-2022 Population	300003	363331	43759	430976	4854979	5993048	320056
Pedestrians per year per 100,000 pop, 2021-2023	2.11	17.71	6.09	5.49	4.34	5.13	

Table D.16. Drivers involved in Wisconsin Crashes producing a Fatal or Severe Pedestrian Injury by Driver Race and Ethnicity, 2017-2023

	Asian	Black	Native American	Hispanic	White	Total Known Race	Unknown Race
2017	4	56	1	18	227	306	51
2018	5	64	5	17	196	287	53
2019	6	70	4	23	197	300	52
2020	4	54	3	15	186	262	60
2021	4	56	3	23	172	258	72
2022	5	37	4	22	207	275	74
2023	5	60	1	24	177	267	78
Total	33	397	21	142	1362	1955	440
2018-2022	24	281	19	100	958	1382	311
							Two or more
Avg 2018-2022 Population	300003	363331	43759	430976	4854979	5993048	320056
Drivers per year per 100,000 pop, 2018-2022	2.67	25.78	14.47	7.73	6.58	7.69	

Table D.17. Wisconsin Bicyclist Fatalities Plus Severe Injuries by Race and Ethnicity, 2021-2023

	Asian	Black	Native American	Hispanic	White	Total Known Race	Unknown Race
2021	2	10	1	7	58	78	23
2022	1	12	1	3	64	81	7
2023	3	27	0	10	70	110	7
Total	6	54	2	20	193	275	390
2021-2023	6	49	2	20	192	269	37
							Two or more
Avg 2018-2022 Population	300003	363331	43759	430976	4854979	5993048	320056
Bicyclists per year per 100,000 pop, 2021-2023	0.67	4.50	1.52	1.55	1.32	1.50	

Table D.18. Drivers involved in Wisconsin Crashes producing a Fatal or Severe Bicyclist Injury by Driver Race and Ethnicity, 2017-2023

	Asian	Black	Native American	Hispanic	White	Total Known Race	Unknown Race
2017	1	18	1	1	59	80	5
2018	1	11	1	2	62	77	6
2019	4	10		4	74	92	9
2020	1	7		4	67	79	7
2021	1	8	1	8	66	84	13
2022	3	8		8	59	78	10
2023	11	8	1	7	68	95	15
Total	22	70	4	34	455	585	65
2018-2022	10	44	2	26	328	410	45
							Two or more
Avg 2018-2022 Population	300003	363331	43759	430976	4854979	5993048	320056
Drivers per year per 100,000 pop, 2018-2022	1.11	4.04	1.52	2.01	2.25	2.28	

Table D.19. Fatal and Severe Pedestrian Injuries by Pedestrian Disability Status

	Wheelchair	Blind	Cane/Crutch	Physically Impaired	None/Not reported	Total
2017	3	1	3	10	339	356
2018			2	14	323	339
2019	1		5	18	315	339
2020	1		2	17	292	312
2021	1	2	1	14	351	369
2022	1		5	14	321	341
2023	3	1	1	12	310	327
Total	10	4	19	99	2251	2383
Average per year, 2017-2023	1.7	1.3	2.7	14.1	321.6	340.4
Percent of Total	0.5%	0.4%	0.8%	4.2%	94.5%	100.0%

Table D.20. Fatal and Severe Pedestrian Injuries by Vehicle Type, 2017-2023

	Passenger Car	Sport Utility Vehicle	Passenger Van	Utility Truck/ Pickup Truck	Other Vehicle	Total Known Vehicle Type
2017	219	69	15	43	11	357
2018	212	55	8	46	19	340
2019	202	66	13	51	20	352
2020	175	72	12	40	23	322
2021	213	60	7	32	18	330
2022	195	83	12	45	14	349
2023	201	62	15	46	21	345
Total	1417	467	82	303	126	2395

Table D.21. Fatal and Severe Bicyclist Injuries by Vehicle Type, 2017-2023

	Passenger Car	Sport Utility Vehicle	Passenger Van	Utility Truck/ Pickup Truck	Other Vehicle	Total Known Vehicle Type
2017	51	17	4	8	5	85
2018	50	17	2	10	4	83
2019	53	24	4	12	8	101
2020	49	17	1	11	8	86
2021	55	21	4	13	4	97
2022	48	22	0	13	2	85
2023	49	29	4	13	7	102
Total	355	147	19	80	38	639

Table D.22. Proportion of Pedestrian FSI Crashes by Time Period: Milwaukee County, Dane County, and All other counties, 2008-2012 vs. 2018-2022

	12-2a	3-5a	6-8a	9-11a	12-2p	3-5p	6-8p	9-11p	Total
Milwaukee County, 2008-2012	14.8%	2.2%	10.0%	8.5%	12.0%	21.6%	16.3%	14.6%	100.0%
Milwaukee County, 2018-2022	11.3%	4.5%	5.6%	7.5%	12.7%	20.4%	19.5%	18.5%	100.0%
Dane County, 2008-2012	7.7%	3.8%	6.9%	11.5%	15.4%	22.3%	21.5%	10.8%	100.0%
Dane County, 2018-2022	12.3%	5.8%	4.5%	6.5%	13.0%	18.8%	26.6%	12.3%	100.0%
All other counties, 2008-2012	10.6%	3.6%	11.1%	11.3%	15.0%	21.2%	15.8%	11.3%	100.0%
All other counties, 2018-2022	8.5%	5.0%	9.0%	8.5%	13.3%	19.2%	22.2%	14.3%	100.0%